



What's really inside the **Commodore 64™**

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INTRODUCTION

The purpose of this book is to provide a detailed listing of the ROM contents for the Commodore 64 microcomputer. For programmers working in assembler language, or those wanting a more complete understanding of BASIC, this should prove to be very useful.

Since there are two ROM areas, A000-BFFF and E000-FFFF, which can be disabled separately, the listing is in two distinct parts, each with its own cross-reference listing.

The columns in the listing, from left to right, are:

1. address
2. object code
3. line number
4. label
5. instruction mnemonic
6. operand
7. comments

All labels have a four (two for zero page) hexadecimal character suffix representing the actual address:
The single character prefixes have the following meanings:

B - Branch label
J - Jump label
S - Subroutine label
T - Table (data) label
W - Word label
Z - Zero page label
X - External label (address outside of zero page
and current ROM area)

The mnemonics are standard MOS Technology. Operands may be symbolic, immediate hexadecimal (preceded by a dollars sign) or low/high order immediate (preceded by </>).

At the end of each of the two listings you will find a cross-reference. For each label, listed in alphabetical order, you will find the label value and each line number where the label was used.


```

1      .L
2      .H
3 ;CBM-64-Part One
4 ;
5 ;
0000   6 Z00    = $00      ;6510 data direction register
0001   7 Z01    = $01      ;6510 I/O register
0002   8 ;      bit 0 (output) 0=RAM at $A000-$BFFF (BASIC area)
0003   9 ;      bit 1 (output) 0=RAM at $E000-$FFFF (Kernal area)
0004  10 ;     bit 2 (output) 0=access CRT shapes at $D000-$DFFF
0005  11 ;     bit 3 (output) cassette write line
0006  12 ;     bit 4 (input)  cassette sense line
0007  13 ;     bit 5 (output) cassette motor control
0008  14 ;     bit 6 unused
0009  15 ;     bit 7 unused
0002  16 Z02    = $02      ;dummy address for offset
0003  17 Z03    = $03      ;fixed-float vector
0004  18 Z04    = $04      ;high byte of same
0007  19 Z07    = $07      ;separator/terminator/work field
0008  20 Z08    = $08      ;terminator/AND work field
0009  21 Z09    = $09      ;character position for TAB
000B  22 Z0B    = $0B      ;length BASIC line/AND-OR switch/# DIM
000C  23 Z0C    = $0C      ;reference/declaration flag
000D  24 Z0D    = $0D      ;type: FF=string, 00=numeric
000E  25 Z0E    = $0E      ;type: 80=integer, 00=floating point
000F  26 Z0F    = $0F      ;DATA/string/error flag
0010  27 Z10    = $10      ;subscript/fn flag/integers-arrays flag
0011  28 Z11    = $11      ;0=input, $40=get, $98=read
0012  29 Z12    = $12      ;<=> operator
0013  30 Z13    = $13      ;CMD file number
0014  31 Z14    = $14      ;integer value (work)
0015  32 Z15    = $15      ;high byte of same
0016  33 Z16    = $16      ;string descriptor stack index
0017  34 Z17    = $17      ;previous string descriptor stack index
0018  35 Z18    = $18      ;high byte of same
0019  36 Z19    = $19      ;bottom of string descriptor stack
0022  37 Z22    = $22      ;utility pointer area
0023  38 Z23    = $23      ;"
0024  39 Z24    = $24      ;"
0025  40 Z25    = $25      ;"
0026  41 Z26    = $26      ;product for multiplication
0027  42 Z27    = $27      ;"
0028  43 Z28    = $28      ;"
0029  44 Z29    = $29      ;"
002B  45 Z2B    = $2B      ;pointer to start of BASIC
002C  46 Z2C    = $2C      ;high byte of same
002D  47 Z2D    = $2D      ;pointer start of variables
002E  48 Z2E    = $2E      ;high byte of same
002F  49 Z2F    = $2F      ;pointer to start of arrays
0030  50 Z30    = $30      ;high byte of same
0031  51 Z31    = $31      ;pointer to end of arrays
0032  52 Z32    = $32      ;high byte of same
0033  53 Z33    = $33      ;pointer to start of string storage
0034  54 Z34    = $34      ;high byte of same
0035  55 Z35    = $35      ;utility string pointer
0036  56 Z36    = $36      ;high byte of same
0037  57 Z37    = $37      ;pointer to limit of memory
0038  58 Z38    = $38      ;high byte of same
0039  59 Z39    = $39      ;current BASIC line number

```

003A	60 Z3A	=	\$3A	;high byte of same
003B	61 Z3B	=	\$3B	;previous BASIC line number
003C	62 Z3C	=	\$3C	;high byte of same
003D	63 Z3D	=	\$3D	;pointer to BASIC statement for CONT
003E	64 Z3E	=	\$3E	;high byte of same
003F	65 Z3F	=	\$3F	;current DATA line number
0040	66 Z40	=	\$40	;high byte of same
0041	67 Z41	=	\$41	;current DATA address
0042	68 Z42	=	\$42	;high byte of same
0043	69 Z43	=	\$43	;temporary read pointer
0044	70 Z44	=	\$44	;high byte of same
0045	71 Z45	=	\$45	;current variable name
0046	72 Z46	=	\$46	;second byte of same
0047	73 Z47	=	\$47	;current variable address
0048	74 Z48	=	\$48	;high byte of same
0049	75 Z49	=	\$49	;variable pointer for FOR/NEXT
004A	76 Z4A	=	\$4A	;high byte of same
004B	77 Z4B	=	\$4B	;save area
004C	78 Z4C	=	\$4C	;high byte of same
004D	79 Z4D	=	\$4D	;comparison symbol accumulator
004E	80 Z4E	=	\$4E	;misc. work area
004F	81 Z4F	=	\$4F	; "
0050	82 Z50	=	\$50	; "
0051	83 Z51	=	\$51	; "
0053	84 Z53	=	\$53	; "
0055	85 Z55	=	\$55	; "
0056	86 Z56	=	\$56	; "
0057	87 Z57	=	\$57	;misc. numeric work area
0058	88 Z58	=	\$58	; "
0059	89 Z59	=	\$59	; "
005A	90 Z5A	=	\$5A	; "
005B	91 Z5B	=	\$5B	; "
005C	92 Z5C	=	\$5C	; "
005D	93 Z5D	=	\$5D	; "
005E	94 Z5E	=	\$5E	; "
005F	95 Z5F	=	\$5F	; "
0060	96 Z60	=	\$60	; "
0061	97 Z61	=	\$61	;floating point accu # 1 - exponent
0062	98 Z62	=	\$62	;flop # 1 - mantissa
0063	99 Z63	=	\$63	; "
0064	100 Z64	=	\$64	; "
0065	101 Z65	=	\$65	; "
0066	102 Z66	=	\$66	;flop # 1 - sign
0067	103 Z67	=	\$67	;saved sign of flop accu
0068	104 Z68	=	\$68	;flop accu # 1 padding
0069	105 Z69	=	\$69	;flop accu # 2 thru Z6E
006A	106 Z6A	=	\$6A	
006B	107 Z6B	=	\$6B	
006C	108 Z6C	=	\$6C	
006D	109 Z6D	=	\$6D	
006E	110 Z6E	=	\$6E	
006F	111 Z6F	=	\$6F	;sign comparison accu #1 vs accu # 2
0070	112 Z70	=	\$70	;work pointer/guard bit
0071	113 Z71	=	\$71	;output index
0072	114 Z72	=	\$72	;high byte of same
007A	115 Z7A	=	\$7A	;current character address
007B	116 Z7B	=	\$7B	;high byte of same

```

0054      118 X0054 = $54      ;JMP vector for functions
0073      119 X0073 = $73      ;get next character
0079      120 X0079 = $79      ;get current character
0080      121 X0080 = $80      ;check for numeric character
0100      122 X0100 = $0100    ;bottom of stack
0101      123 X0101 = $0101    ;work area for fip to string conversion
0102      124 X0102 = $0102    ;"
0103      125 X0103 = $0103    ;"
0104      126 X0104 = $0104    ;"
01FE      127 X01FE = $01FE    ;line number for line in input buffer
01FF      128 X01FF = $01FF    ;high byte of same
0200      129 X0200 = $0200    ;BASIC input buffer
130 ;
131 ;Operating System vector table
132 ;
0300      133 X0300 = $0300    ;error message link, std value = $E38B
0302      134 X0302 = $0302    ;BASIC warm start vector, std = $A483
0304      135 X0304 = $0304    ;crunch BASIC tokens, std = $A57C
0306      136 X0306 = $0306    ;print tokens vector, std value = $A71A
0308      137 X0308 = $0308    ;execute stmt vector, std value = $A7E4
030A      138 X030A = $030A    ;get arithmetic element, std = $AE86
0310      139 X0310 = $0310    ;USR JMP vector, std value = $B248
0314      140 W0314 = $0314    ;IRQ vector, std value = $EA31
0316      141 W0316 = $0316    ;BRK vector, std value = $FE66
0318      142 W0318 = $0318    ;NMI vector, std value = $FE47
031A      143 W031A = $031A    ;OPEN vector, std value = $F34A
031C      144 W031C = $031C    ;CLOSE vector, std value = $F291
031E      145 W031E = $031E    ;set input vector, std value = $F20E
0320      146 W0320 = $0320    ;set output vector, std value = $F250
0322      147 W0322 = $0322    ;restore I/O vector, std value = $F333
0324      148 W0324 = $0324    ;INPUT vector, std value = $F157
0326      149 W0326 = $0326    ;OUTPUT vector, std value = $F1CA
0328      150 W0328 = $0328    ;test Stop Key vector, std value = $F6ED
032A      151 W032A = $032A    ;GET vector, std value = $F13E
032C      152 W032C = $032C    ;close files and channels, std = $F32F
032E      153 W032E = $032E    ;unused vector, std value = $FE66 (BRK)
0330      154 W0330 = $0330    ;Load RAM vector, std value = $F4A5
0332      155 W0332 = $0332    ;Save RAM vector, std value = $F5ED
156 ;
033C      157     .OR $33C
033C      158     .DS 192      ;cassette buffer
03FC      159     .DS 4
0400      160     .DS 1000    ;video RAM
07E8      161     .DS 24      ;sprite pointers
0800      162     .DS $8800    ;standard BASIC text area

```

9FEA	164 X9FEA =	\$9FEA	;address to access function jump table
E000	165 XE000 =	\$E000	;continuation of RND routine
E043	166 XE043 =	\$E043	;compute odd degrees for SIN and ATN
E097	167 WEO97 =	\$E097	;RND command
E10C	168 XE10C =	\$E10C	;output a character
E112	169 XE112 =	\$E112	;input a character
E118	170 XE118 =	\$E118	;set output device
E11E	171 XE11E =	\$E11E	;set input device
E124	172 XE124 =	\$E124	;get a character from current device
E12A	173 WE12A =	\$E12A	;SYS command
E156	174 WE156 =	\$E156	;SAVE command
E165	175 WE165 =	\$E165	;VERIFY command
E168	176 WE168 =	\$E168	;LOAD command
E1BE	177 WE1BE =	\$E1BE	;OPEN command
E1C7	178 WE1C7 =	\$E1C7	;CLOSE command
E264	179 WE264 =	\$E264	;COS command
E26B	180 WE26B =	\$E26B	;SIN command
E2B4	181 WE2B4 =	\$E2B4	;TAN command
E30E	182 WE30E =	\$E30E	;ATN command
E37B	183 WE37B =	\$E37B	;Warn Start entry
E386	184 XE386 =	\$E386	;print message READY
E394	185 WE394 =	\$E394	;RESET routine
FF90	186 XFF90 =	\$FF90	;control kernal messages
FFB7	187 XFBF7 =	\$FFB7	;read I/O status word
FFCC	188 XFFCC =	\$FFCC	;restore I/O devices to default
FFDB	189 XFFDB =	\$FFDB	;set real time clock
FFDE	190 XFFDE =	\$FFDE	;read real time clock
FFE1	191 XFFE1 =	\$FFE1	;check Stop key
FFE7	192 XFFE7 =	\$FFE7	;Close all channels and files
FFF0	193 XFFFO =	\$FFF0	;Read/Set XY cursor position

A000	195	.OR \$A000
A000 94E3	196	.W WE394 ;RESET address
A002 7BE3	197	.W WE37B ;Warm Start address
	198 ;	
	199 ;program identifier (not tested)	
	200 ;	
A004 43424D	201	.BY ^C,^B,^M,^B,^A,^S,^I,^C
	202 ;	
	203 ;address table for BASIC commands	
	204 ;address - 1 used since routines reached via RTS	
	205 ;	
A00C 30A8	206	TAOOC .W WA831-1 ;END
A00E 41A7	207	.W WA742-1 ;FOR
A010 1DAD	208	.W WAD1E-1 ;NEXT
A012 F7A8	209	.W WA8F8-1 ;DATA
A014 A4AB	210	.W WABA5-1 ;INPUT#
A016 BEAB	211	.W WABB1-1 ;INPUT
A018 80B0	212	.W WB081-1 ;DIM
A01A 05AC	213	.W WAC06-1 ;READ
A01C A6A9	214	.W WA9A5-1 ;LET
A01E 9FA8	215	.W WA8A0-1 ;GOTO
A020 70A8	216	.W WA871-1 ;RUN
A022 27A9	217	.W WA928-1 ;IF
A024 1CA8	218	.W WA81D-1 ;RESTORE
A026 82A8	219	.W WA883-1 ;GOSUB
A028 D1A8	220	.W WA8D2-1 ;RETURN
A02A 3AA9	221	.W WA93B-1 ;REM
A02C 2E8A	222	.W WA82F-1 ;STOP
A02E 4AA9	223	.W WA94B-1 ;ON
A030 2CB8	224	.W WB82D-1 ;WAIT
A032 67E1	225	.W WE168-1 ;LOAD
A034 55E1	226	.W WE156-1 ;SAVE
A036 64E1	227	.W WE165-1 ;VERIFY
A038 B2B3	228	.W WB3B3-1 ;DEF
A03A 23B8	229	.W WB824-1 ;POKE
A03C 7FAA	230	.W WAA80-1 ;PRINT#
A03E 9FAA	231	.W WAAA0-1 ;PRINT
A040 56A8	232	.W WA857-1 ;CONT
A042 9BA6	233	.W WA69C-1 ;LIST
A044 5DA6	234	.W WA65E-1 ;CLR
A046 85AA	235	.W WAA86-1 ;CMD
A048 29E1	236	.W WE12A-1 ;SYS
A04A BDE1	237	.W WE1BE-1 ;OPEN
A04C C6E1	238	.W WE1C7-1 ;CLOSE
A04E 7AAB	239	.W WAB7B-1 ;GET
A050 41A6	240	.W WA642-1 ;NEW

```

242 ;address table for BASIC functions
243 ;
A052 39BC 244 .W WBC39 ;SGN
A054 CCBC 245 .W WBCCC ;INT
A056 58BC 246 .W WBC58 ;ABS
A058 1003 247 .W X0310 ;USR
A05A 7DB3 248 .W WB37D ;FRE
A05C 9EB3 249 .W WB39E ;POS
A05E 71BF 250 .W WBF71 ;SQR
A060 97E0 251 .W WE097 ;RND
A062 EAB9 252 .W WB9EA ;LOG
A064 EDBF 253 .W WBFED ;EXP
A066 64E2 254 .W WE264 ;COS
A068 6BE2 255 .W WE26B ;SIN
A06A B4E2 256 .W WE2B4 ;TAN
A06C OEE3 257 .W WE30E ;ATN
A06E 0DB8 258 .W WB80D ;PEEK
A070 7CB7 259 .W WB77C ;LEN
A072 65B4 260 .W WB465 ;STR$
A074 ADB7 261 .W WB7AD ;VAL
A076 8BB7 262 .W WB78B ;ASC
A078 ECB6 263 .W WB6EC ;CHR$
A07A 00B7 264 .W WB700 ;LEFT$
A07C 2CB7 265 .W WB72C ;RIGHT$
A07E 37B7 266 .W WB737 ;MID$
267 ;
268 ;table of priorities and addresses
269 ;for diadic operators
270 ;
A080 79 271 TA080 .BY $79
A081 69B8 272 .W WB86A-1 ;plus
273 ;
A083 79 274 .BY $79
A084 52B8 275 .W WB853-1 ;minus
276 ;
A086 7B 277 .BY $7B
A087 2ABA 278 .W WBA2B-1 ;times
279 ;
A089 7B 280 .BY $7B
A08A 11BB 281 .W WBB12-1 ;divided by
282 ;
A08C 7F 283 .BY $7F
A08D 7ABF 284 .W WBF7B-1 ;raise to power
285 ;
A08F 50 286 .BY $50
A090 E8AF 287 .W WAFFE9-1 ;logical AND
288 ;
A092 46 289 .BY $46
A093 E5AF 290 .W WAFFE6-1 ;logical OR
291 ;
A095 7D 292 .BY $7D
A096 B3BF 293 .W WBFB4-1 ;monadic minus
294 ;
A098 5A 295 .BY $5A
A099 D3AE 296 .W WAED4-1 ;monadic NOT
297 ;
A09B 64 298 .BY $64
A09C 15B0 299 .W WB016-1 ;> = <

```

```

301 ;table of keywords
302 ;same sequence as address table TA00C
303 ;
A09E 454EC4 304 TAO9E .BY ^E,^N,^D+$80
AOA1 464FD2 305 .BY ^F,^O,^R+$80
AOA4 4E4558 306 .BY ^N,^E,^X,^T+$80
AOA8 444154 307 .BY ^D,^A,^T,^A+$80
AOAC 494E50 308 .BY ^I,^N,^P,^U,^T,^#+$80
AOB2 494E50 309 .BY ^I,^N,^P,^U,^T+$80
AOB7 4449CD 310 .BY ^D,^I,^M+$80
AOBA 524541 311 .BY ^R,^E,^A,^D+$80
AOBE 4C45D4 312 .BY ^L,^E,^T+$80
AOC1 474F54 313 .BY ^G,^O,^T,^D+$80
AOC5 5255CE 314 .BY ^R,^U,^N+$80
AOC8 49C6 315 .BY ^I,^F+$80
AOCA 524553 316 .BY ^R,^E,^S,^T,^O,^R,^E+$80
AOD1 474F53 317 .BY ^G,^O,^S,^U,^B+$80
AOD6 524554 318 .BY ^R,^E,^T,^U,^R,^N+$80
AODC 5245CD 319 .BY ^R,^E,^M+$80
AODF 53544F 320 .BY ^S,^T,^O,^P+$80
AOE3 4FCF 321 .BY ^O,^N+$80
AOE5 574149 322 .BY ^W,^A,^I,^T+$80
AOE9 4C4F41 323 .BY ^L,^O,^A,^D+$80
AOED 534156 324 .BY ^S,^A,^V,^E+$80
AOF1 564552 325 .BY ^V,^E,^R,^I,^F,^Y+$80
AOF7 4445C6 326 .BY ^D,^E,^F+$80
AOFA 504F4B 327 .BY ^P,^O,^K,^E+$80
AOFE 505249 328 .BY ^P,^R,^I,^N,^T,^#+$80
A104 505249 329 .BY ^P,^R,^I,^N,^T+$80
A109 434F4E 330 .BY ^C,^O,^N,^T+$80
A10D 4C4953 331 .BY ^L,^I,^S,^T+$80
A111 434CD2 332 .BY ^C,^L,^R+$80
A114 434DC4 333 .BY ^C,^M,^D+$80
A117 5359D3 334 .BY ^S,^Y,^S+$80
A11A 4F5045 335 .BY ^O,^P,^E,^N+$80
A11E 434CAF 336 .BY ^C,^L,^O,^S,^E+$80
A123 4745D4 337 .BY ^G,^E,^T+$80
A126 4E45D7 338 .BY ^N,^E,^W+$80

```

```

340 ;table of functions
341 ;
A129 544142 342      .BY 'T,'A,'B,'(+$80
A12D 54CF 343      .BY 'T,'0+$80
A12F 46CE 344      .BY 'F,'N+$80
A131 535043 345      .BY 'S,'P,'C,'(+$80
A135 544845 346      .BY 'T,'H,'E,'N+$80
A139 4E4FD4 347      .BY 'N,'O,'T+$80
A13C 535445 348      .BY 'S,'T,'E,'P+$80
A140 AB 349      .BY '++$80
A141 AD 350      .BY '++$80
A142 AA 351      .BY '*+$80
A143 AF 352      .BY '/+$80
A144 DE 353      .BY $DE      ;exponent sign
A145 414EC4 354      .BY 'A,'N,'D+$80
A148 4FD2 355      .BY 'O,'R+$80
A14A BE 356      .BY '>+$80
A14B BD 357      .BY '=+$80
A14C BC 358      .BY '<+$80
A14D 5347CE 359      .BY 'S,'G,'N+$80
A150 494ED4 360      .BY 'I,'N,'T+$80
A153 4142D3 361      .BY 'A,'B,'S+$80
A156 5553D2 362      .BY 'U,'S,'R+$80
A159 4652C5 363      .BY 'F,'R,'E+$80
A15C 504FD3 364      .BY 'P,'O,'S+$80
A15F 5351D2 365      .BY 'S,'Q,'R+$80
A162 524EC4 366      .BY 'R,'N,'D+$80
A165 4C4FC7 367      .BY 'L,'O,'G+$80
A168 4558D0 368      .BY 'E,'X,'P+$80
A16B 434FD3 369      .BY 'C,'O,'S+$80
A16E 5349CE 370      .BY 'S,'I,'N+$80
A171 5441CE 371      .BY 'T,'A,'N+$80
A174 4154CE 372      .BY 'A,'T,'N+$80
A177 504545 373      .BY 'P,'E,'E,'K+$80
A17B 4C45CE 374      .BY 'L,'E,'N+$80
A17E 535452 375      .BY 'S,'T,'R,'S+$80
A182 5641CC 376      .BY 'V,'A,'L+$80
A185 4153C3 377      .BY 'A,'S,'C+$80
A188 434852 378      .BY 'C,'H,'R,'S+$80
A18C 4C4546 379      .BY 'L,'E,'F,'T,'S+$80
A191 524947 380      .BY 'R,'I,'C,'H,'T,'S+$80
A197 4D4944 381      .BY 'M,'I,'D,'S+$80
382 ;
383 ;other commands
384 ;
A19B 47CF 385      .BY 'G,'0+$80
A19D 00 386      .BY $00      ;end of keywords

```

```

388 ;error messages
389 ;
A19E 544F4F .BY ^T,^O,^O,^ ,^M,^A,^N,^Y,^ ,^F,^I,^L,^E,^S+$80
A1AC 46494C .BY ^F,^I,^L,^E,^ ,^O,^P,^E,^N+$80
A1B5 46494C .BY ^F,^I,^L,^E,^ ,^N,^O,^T,^ ,^O,^P,^E,^N+$80
A1C2 46494C .BY ^F,^I,^L,^E,^ ,^N,^O,^T,^ ,^F,^O,^U,^N,^D+$80
A1DO 444556 .BY ^D,^E,^V,^I,^C,^E,^ ,^N,^O,^T,
A1DB 505245 .BY ^P,^R,^E,^S,^E,^N,^T+$80
A1E2 4E4F54 .BY ^N,^O,^T,^ ,^I,^N,^P,^U,^T,^ ,^F,^I,^L,^E+$80
A1FO 4E4F54 .BY ^N,^O,^T,^ ,^O,^U,^T,^P,^U,^T,^ ,^F,^I,^L,^E+$80
A1FF 4D4953 .BY ^M,^I,^S,^S,^I,^N,^G,^ ,^F,^I,^L,^E,
A2OC 4E414D .BY ^N,^A,^M,^E+$80
A210 494C4C 400 TA210 .BY ^I,^L,^E,^G,^A,^L,^ ,^D,^E,^V,^I,^C,^E,
A21F 4E554D .BY ^N,^U,^M,^B,^E,^R+$80
A225 4E4558 .BY ^N,^E,^X,^T,^ ,^W,^I,^T,^H,^O,^U,^T
A231 20464F 403 .BY ^ ,^F,^O,^R+$80
A235 53594E 404 TA235 .BY ^S,^Y,^N,^T,^A,^X+$80
A23B 524554 405 TA23B .BY ^R,^E,^T,^U,^R,^N,^ ,^W,^I,^T,^H,^O,^U,^T,
A24A 474F53 406 .BY ^G,^O,^S,^U,^B+$80
A24F 4F5554 407 TA24F .BY ^O,^U,^T,^ ,^O,^F,^ ,^D,^A,^T,^A+$80
A25A 494C4C 408 TA25A .BY ^I,^L,^L,^E,^G,^A,^L
A261 205155 409 .BY ^ ,^Q,^U,^A,^N,^T,^I,^T,^Y+$80
A26A 4F5645 410 TA26A .BY ^O,^V,^E,^R,^F,^L,^O,^W+$80
A272 4F5554 411 TA272 .BY ^O,^U,^T,^ ,^O,^F,^ ,^M,^E,^M,^O,^R,^Y+$80
A27F 554E44 412 TA27F .BY ^U,^N,^D,^E,^F,^S27,^D,
A287 535441 413 .BY ^S,^T,^A,^T,^E,^M,^E,^N,^T+$80
A290 424144 414 TA290 .BY ^B,^A,^D,^ ,^S,^U,^B,^S,^C,^R,^I,^P,^T+$80
A29D 524544 415 TA29D .BY ^R,^E,^D,^I,^M,^S27,^D,^ ,^A,^R,^R,^A,^Y+$80
A2AA 444956 416 TA2AA .BY ^D,^I,^V,^I,^S,^I,^O,^N,^ ,^B,^Y
A2B5 205A45 417 .BY ^ ,^Z,^E,^R,^O+$80
A2BA 494C4C 418 TA2BA .BY ^I,^L,^L,^E,^G,^A,^L,^ ,^D,^I,^R,^E,^C,^T+$80
A2C8 545950 419 TA2C8 .BY ^T,^Y,^P,^E,^ ,^M,^I,^S,^M,^A,^T,^C,^H+$80
A2D5 535452 420 TA2D5 .BY ^S,^T,^R,^I,^N,^G,^ ,^T,^O,^O,^ ,^L,^O,^N,^G+$80
A2E4 46494C 421 TA2E4 .BY ^F,^I,^L,^E,^ ,^D,^A,^T,^A+$80
A2ED 464F52 422 TA2ED .BY ^F,^O,^R,^M,^U,^L,^A,^ ,^T,^O,^O,
A2F9 434F4D 423 .BY ^C,^O,^M,^P,^L,^E,^X+$80
A300 43414E 424 TA300 .BY ^C,^A,^N,^S27,^T,^ ,^C,^O,^N,^T,^I,^N,^U,^E+$80
A30E 554E44 425 TA30E .BY ^U,^N,^D,^E,^F,^S27,^D
A315 204655 426 .BY ^ ,^F,^U,^N,^C,^T,^I,^O,^N+$80
A31E 564552 427 TA31E .BY ^V,^E,^R,^I,^F,^Y+$80
A324 4C4F41 428 TA324 .BY ^L,^O,^A,^D+$80

```

```

430 ;error message address table
431 ;index 01-1E loaded into X to reference message table
432 ;
A328 9EA1 433 TA328 .W TA19E ;01 Too Many Files
A32A ACA1 434 .W TA1AC ;02 File Open
A32C B5A1 435 .W TA1B5 ;03 File Not Open
A32E C2A1 436 .W TA1C2 ;04 File Not Found
A330 D0A1 437 .W TA1D0 ;05 Device Not Present
A332 E2A1 438 .W TA1E2 ;06 Not Input File
A334 F0A1 439 .W TA1F0 ;07 Not Output File
A336 FFA1 440 .W TA1FF ;08 Missing File Name
A338 10A2 441 .W TA210 ;09 Illegal Device Number
A33A 25A2 442 .W TA225 ;0A Next Without For
A33C 35A2 443 .W TA235 ;0B Syntax
A33E 3BA2 444 .W TA23B ;0C Return Without Gosub
A340 4FA2 445 .W TA24F ;0D Out Of Data
A342 5AA2 446 .W TA25A ;0E Illegal Quantity
A344 6AA2 447 .W TA26A ;0F Overflow
A346 72A2 448 .W TA272 ;10 Out Of Memory
A348 7FA2 449 .W TA27F ;11 Undef'd Statement
A34A 90A2 450 .W TA290 ;12 Bad Subscript
A34C 9DA2 451 .W TA29D ;13 Redim'd Array
A34E AAA2 452 .W TA2AA ;14 Division By Zero
A350 BAA2 453 .W TA2BA ;15 Illegal Direct
A352 C8A2 454 .W TA2C8 ;16 Type Mismatch
A354 D5A2 455 .W TA2D5 ;17 String Too Long
A356 E4A2 456 .W TA2E4 ;18 File Data
A358 EDA2 457 .W TA2ED ;19 Formula Too Complex
A35A 00A3 458 .W TA300 ;1A Can't Continue
A35C OEA3 459 .W TA30E ;1B Undef'd Function
A35E 1EA3 460 .W TA31E ;1C Verify
A360 24A3 461 .W TA324 ;1D Load
A362 83A3 462 .W TA383 ;1E Break
463 ;
A364 0D4F4B 464 TA364 .BY $0D,`O,`K,$0D,$00
A369 202045 465 TA369 .BY ` ,`E,`R,`R,`O,`R,$00
A371 20494E 466 TA371 .BY ` ,`I,`N,` ,$00
A376 0DOA52 467 TA376 .BY $0D,$0A,`R,`E,`A,`D,`Y,`.,$0D,$0A,$00
A381 0DOA 468 TA381 .BY $0D,$0A
A383 425245 469 TA383 .BY `B,`R,`E,`A,`K,$00,$AO

```

```

471 ;search for "FOR" blocks on stack (code 81)
472 ;
473 ;if Z49/Z4A > $00FF, get FOR block with address = Z49/Z4A
474 ;if Z49/Z4A < $0100, get highest FOR block in Z49/Z4A
475 ;upon exit, X = stack above FOR block
476 ;Z=1 when FOR block found
477 ;Z=0 when FOR block not found
478 ;A=code of block found
479 ;
A38A BA    480 SA38A TSX
A38B E8    481   INX
A38C E8    482   INX
A38D E8    483   INX
A38E E8    484   INX      ;point to highest block
A38F BD0101 485 BA38F LDA X0101,X
A392 C981  486   CMP $81      ;if no FOR block
A394 D021  487   BNE BA3B7    ;return with Z=0
A396 A54A  488   LDA Z4A
A398 D00A  489   BNE BA3A4    ;if no address
A39A BD0201 490   LDA X0102,X    ;get address from highest block
A39D 8549  491   STA Z49
A39F BD0301 492   LDA X0103,X
A3A2 854A  493   STA Z4A
A3A4 DD0301 494 BA3A4 CMP X0103,X    ;compare address to block
A3A7 D007  495   BNE BA3B0
A3A9 A549  496   LDA Z49
A3AB DDO201 497   CMP X0102,X
A3AE F007  498   BEQ BA3B7    ;return with Z=1 if equal
A3B0 8A    499 BA3B0 TXA      ;if not equal
A3B1 18    500   CLC
A3B2 6912  501   ADC $12    ;skip a FOR block
A3B4 AA    502   TAX
A3B5 DOD8  503   BNE BA38F    ;and try again
A3B7 60    504 BA3B7 RTS

```

```

      506 ;move bytes after a check for space
      507 ;
A3B8 2008A4 508 SA3B8 JSR SA408      ;do array area overflow check for AY
A3BB 8531    509 STA Z31           ;set new end of array area
A3BD 8432    510 STY Z32
      511 ;
      512 ;move bytes routine
      513 ;source address in Z5F/Z60
      514 ;end of source address in Z5A/Z5B
      515 ;end of destination address in Z58/Z59
      516 ;
      517 ;highest bytes moved first
      518 ;X and Y at 0 upon return
      519 ;
A3BF 38      520 SA3BF SEC
A3C0 A55A    521 LDA Z5A
A3C2 E55F    522 SBC Z5F
A3C4 8522    523 STA Z22      ;compute length of area to be moved
A3C6 A8      524 TAY          ;Y=low order 8 bits
A3C7 A55B    525 LDA Z5B
A3C9 E560    526 SBC Z60
A3CB AA      527 TAX          ;X=high order 8 bits
A3CC E8      528 INX
A3CD 98      529 TYA
A3CE F023    530 BEQ BA3F3   ;if multiple of 256, skip remainder
A3D0 A55A    531 LDA Z5A
A3D2 38      532 SEC
A3D3 E522    533 SBC Z22
A3D5 855A    534 STA Z5A
A3D7 B003    535 BCS BA3DC   ;Z5A/Z5B points to start source block
A3D9 C65B    536 DEC Z5B
A3DB 38      537 SEC
A3DC A558    538 BA3DC LDA Z58
A3DE E522    539 SBC Z22
A3E0 8558    540 STA Z58
A3E2 B008    541 BCS BA3EC
A3E4 C659    542 DEC Z59   ;Z58/Z59 points to destination
A3E6 9004    543 BCC BA3EC
A3E8 B15A    544 BA3E8 LDA (Z5A),Y ;fetch a byte from source
A3EA 9158    545 STA (Z58),Y ;move it to destination
A3EC 88      546 BA3EC DEY
A3ED D0F9    547 BNE BA3E8   ;repeat for all 256 bytes in a page
A3EF B15A    548 LDA (Z5A),Y ;also last byte
A3F1 9158    549 STA (Z58),Y
A3F3 C65B    550 BA3F3 DEC Z5B   ;point to lower block of source
A3F5 C659    551 DEC Z59   ;point to lower block of destination
A3F7 CA      552 DEX
A3F8 D0F2    553 BNE BA3EC   ;repeat for all blocks
A3FA 60      554 RTS

```

```

556 ;test for 2 * A bytes available on the stack
557 ;
558 ;allow 62 bytes extra for interrupt processing
559 ;indicate fatal error if not enough space left
560 ;
A3FB 0A      561 SA3FB ASL A      ;multiply A * 2
A3FC 693E    562 ADC $3E       ;62 bytes extra
A3FE B035    563 BCS BA435     ;error if overflow
A400 8522    564 STA Z22
A402 BA      565 TSX
A403 E422    566 CPX Z22      ;if stack above result
A405 902E    567 BCC BA435     ;overflow error
A407 60      568 RTS
569 ;
570 ;array area overflow check
571 ;
A408 C434    572 SA408 CPY Z34   ;if A below string storage pointer
A40A 9028    573 BCC BA434     ;return
A40C D004    574 BNE BA412
A40E C533    575 CMP Z33
A410 9022    576 BCC BA434
A412 48      577 BA412 PHA      ;save AY
A413 A209    578 LDX $09
A415 98      579 TYA
A416 48      580 BA416 PHA
A417 B557    581 LDA Z57,X      ;save Z58-Z61 on stack
A419 CA      582 DEX
A41A 10FA    583 BPL BA416
A41C 2026B5  584 JSR SB526     ;perform string cleanup
A41F A2F7    585 LDX $F7
A421 68      586 BA421 PLA
A422 9561    587 STA Z61,X      ;restore Z58-Z61 from stack
A424 E8      588 INX
A425 30FA    589 BMI BA421
A427 68      590 PLA
A428 A8      591 TAY
A429 68      592 PLA      ;restore AY
A42A C434    593 CPY Z34      ;if AY still above string pointer,
A42C 9006    594 BCC BA434     ;then error OUT OF MEMORY
A42E D005    595 BNE BA435
A430 C533    596 CMP Z33
A432 B001    597 BCS BA435
A434 60      598 BA434 RTS
599 ;
600 ;fatal error OUT OF MEMORY
601 ;
A435 A210    602 BA435 LDX $10     ;point to error OUT OF MEMORY

```

```

604 ;handle error messages
605 ;
606 ;X points to error message address table TA328
607 ;
A437 6C0003 608 JA437 JMP (X0300) ;handle error message (normally A43A)
609 ;
610 ;standard error message handler
611 ;
A43A 8A 612 TXA
A43B 0A 613 ASL A
A43C AA 614 TAX
A43D BD26A3 615 LDA TA328-2,X ;fetch address from error message table
A440 8522 616 STA Z22
A442 BD27A3 617 LDA TA328-1,X
A445 8523 618 STA Z23
A447 20CCFF 619 JSR XFFCC ;restore 1/0 devices to default
A44A A900 620 LDA $00
A44C 8513 621 STA Z13 ;set default CMD output file
A44E 20D7AA 622 JSR SAAD7 ;end line on CMD output file
A451 2045AB 623 JSR SAB45 ;print question mark on output file
A454 A000 624 LDY $00
A456 B122 625 BA456 LDA (Z22),Y
A458 48 626 PHA
A459 297F 627 AND $7F
A45B 2047AB 628 JSR SAB47 ;print a character on output file
A45E C8 629 INY
A45F 68 630 PLA
A460 10F4 631 BPL BA456 ;repeat if end of message not reached
A462 207AA6 632 JSR SA67A ;reset stack and program pointers
A465 A969 633 LDA <TA369
A467 A0A3 634 LDY >TA369 ;set AY to message ERROR
A469 201EAB 635 JA469 JSR SAB1E ;print message from AY
A46C A43A 636 LDY Z3A ;if in direct mode
A46E C8 637 INY
A46F F003 638 BEQ BA474 ;restart BASIC
A471 20C2BD 639 JSR SBDC2 ;else print LN STATEMENT and #
A474 A976 640 BA474 LDA <TA376
A476 A0A3 641 LDY >TA376 ;set AY to message READY
A478 201EAB 642 JSR SAB1E ;print READY message
A47B A980 643 LDA $80
A47D 2090FF 644 JSR XFF90 ;set kernal msg flag for direct mode
A480 6C0203 645 BA480 JMP (X0302) ;perform warm start (normally A483)
646 ;
647 ;standard warm start routine (BASIC Interpreter)
648 ;
A483 2060A5 649 JSR SA560 ;get statement into the input buffer
A486 867A 650 STX Z7A ;move beginning of line address
A488 847B 651 STY Z7B ;to current character address
A48A 207300 652 JSR X0073 ;get next character of statement
A48D AA * 653 TAX
A48E F0F0 654 BEQ BA480 ;skip statement if end of line
A490 A2FF 655 LDX $FF
A492 863A 656 STX Z3A ;set Run/Direct switch to Direct
A494 9006 657 BCC BA49C ;if no line number,
A496 2079A5 658 JSR SA579 ;encode keywords in statement
A499 4CE1A7 659 JMP JA7E1 ;and go execute statement

```

```

661 ;numbered statements
662 ;
A49C 206BA9 663 BA49C JSR SA96B ;gather line number into Z14/Z15
A49F 2079A5 664 JSR SA579 ;encode keywords in statement
A4A2 840B 665 STY ZOB ;save index for end of line
A4A4 2013A6 666 JSR SA613 ;search for statement in program
A4A7 9044 667 BCC BA4ED ;if not found, insert line
668 ;
669 ;delete old statement (indexed from Z5F/Z60)
670 ;
A4A9 A001 671 LDY $01
A4AB B15F 672 LDA (Z5F),Y ;move low of pointer to next statement
A4AD 8523 673 STA Z23
A4AF A52D 674 LDA Z2D ;move low of ptr beyond last statement
A4B1 8522 675 STA Z22
A4B3 A560 676 LDA Z60 ;move byte of ptr to current statement
A4B5 8525 677 STA Z25
A4B7 A55F 678 LDA Z5F ;low byte of ptr to current statement
A4B9 88 679 DEY ;-low byte of pointer to next statement
A4BA F15F 680 SBC (Z5F),Y ;length of gap in 2's complement
A4BC 18 681 CLC
A4BD 652D 682 ADC Z2D ;+ low byte ptr beyond last statement
A4BF 852D 683 STA Z2D ;= new pointer beyond last statement
A4C1 8524 684 STA Z24 ;also saved
A4C3 A52E 685 LDA Z2E ;high byte of ptr beyond last statement
A4C5 69FF 686 ADC $FF ;+ carry
A4C7 852E 687 STA Z2E ;= new high of pointer beyond last statm
A4C9 E560 688 SBC Z60 ;=high of pointer to current statm
A4CB AA 689 TAX ;=high byte of # of bytes to move
A4CC 38 690 SEC
A4CD A55F 691 LDA Z5F ;low byte of ptr to current statement
A4CF E52D 692 SBC Z2D ;-low of pointer beyond last statement
A4D1 A8 693 TAY ;number of bytes to move
A4D2 B003 694 BCS BA4D7 ;if necessary,
A4D4 E8 695 INX ;adjust carry
A4D5 C625 696 DEC Z25 ;also adjust low end pointer
A4D7 18 697 BA4D7 CLC
A4D8 6522 698 ADC Z22
A4DA 9003 699 BCC BA4DF
A4DC C623 700 DEC Z23
A4DE 18 701 CLC
A4DF B122 702 BA4DF LDA (Z22),Y ;get byte from low end
A4E1 9124 703 STA (Z24),Y ;move to new low end
A4E3 C8 704INY
A4E4 DOF9 705 BNE BA4DF ;repeat until page moved
A4E6 E623 706 INC Z23 ;update page pointers
A4E8 E625 707 INC Z25
A4EA CA 708 DEX
A4EB DOF2 709 BNE BA4DF ;repeat until last block moved

```

```

711 ;insert new line at location indicated by Z5F/Z60
712 ;
A4ED 2059A6 713 BA4ED JSR SA659 ;reset program pointers
A4FO 2033A5 714 JSR SA533 ;relink BASIC lines
A4F3 AD0002 715 LDA X0200 ;if first byte of new line is a null,
A4F6 F088 716 BEQ BA480 ;don't insert
A4F8 18 717 CLC
A4F9 A52D 718 LDA Z2D ;get low byte of pointer to end of line
A4FB 855A 719 STA Z5A ;save as end pointer for move
A4FD 650B 720 ADC Z0B ;add length of line to be inserted
A4FF 8558 721 STA Z58 ;save as end output pointer for move
A501 A42E 722 LDY Z2E ;save high bytes also
A503 845B 723 STY Z5B
A505 9001 724 BCC BA508
A507 C8 725 INY
A508 8459 726 BA508 STY Z59
A50A 20B8A3 727 JSR SA3B8 ;move bytes and check for overflow
A50D A514 728 LDA Z14 ;move line number
A50F A415 729 LDY Z15
A511 8DFE01 730 STA X01FE ;to fields preceding input buffer
A514 8CFF01 731 STY X01FF
A517 A531 732 LDA Z31 ;use new upper limit
A519 A432 733 LDY Z32
A51B 852D 734 STA Z2D ;as new end of program
A51D 842E 735 STY Z2E
A51F A40B 736 LDY Z0B ;get length of line to be inserted
A521 88 737 DEY
A522 B9FC01 738 BA522 LDA X0200-4,Y ;move new line
A525 915F 739 STA (Z5F),Y ;into gap
A527 88 740 DEY
A528 10F8 741 BPL BA522 ;loop until line moved
A52A 2059A6 742 JSR SA659 ;reset program pointers
A52D 2033A5 743 JSR SA533 ;relink BASIC lines
A530 4C80A4 744 JMP BA480 ;go back to BASIC

```

```

746 ;relink BASIC
747 ;
A533 A52B 748 SA533 LDA Z2B      ;get pointer to beginning of BASIC text
A535 A42C 749 LDY Z2C
A537 8522 750 STA Z22      ;hold in temporary pointer
A539 8423 751 STY Z23
A53B 18   752 CLC
A53C A001 753 BA53C LDY $01
A53E B122 754 LDA (Z22),Y      ;get byte at current statement + 1
A540 F01D 755 BEQ BA55F      ;if at 0, end of program reached
A542 A004 756 LDY $04      ;set start index
A544 C8   757 BA544 INY      ;increment index
A545 B122 758 LDA (Z22),Y      ;scan to end of line
A547 D0FB 759 BNE BA544
A549 C8   760 INY
A54A 98   761 TYA
A54B 6522 762 ADC Z22      ;compute pointer to next statement
A54D AA   763 TAX
A54E A000 764 LDY $00
A550 9122 765 STA (Z22),Y      ;set link in beginning of statement
A552 A523 766 LDA Z23
A554 6900 767 ADC $00
A556 C8   768 INY
A557 9122 769 STA (Z22),Y      ;set new current statement address
A559 8622 770 STX Z22
A55B 8523 771 STA Z23
A55D 90DD 772 BCC BA53C      ;repeat until all statements processed
A55F 60   773 BA55F RTS
    774 ;
    775 ;get statement into input buffer
    776 ;
A560 A200 777 SA560 LDX $00      ;start with index=0
A562 2012E1 778 BA562 JSR XE112 ;get clean character from CMD file
A565 C90D 779 CMP $0D      ;if Return,
A567 FOOD 780 BEQ BA576      ;go end line
A569 9D0002 781 STA X0200,X      ;else store character in input buffer
A56C E8   782 INX
A56D E059 783 CPX $59      ;if statement not too long
A56F 90F1 784 BCC BA562      ;repeat
A571 A217 785 LDX $17      ;else point to message STRING TOO LONG
A573 4C37A4 786 JMP JA437      ;and print error message
    787 ;
A576 4CCAAA 788 BA576 JMP JAACA ;go end line

```

```

A579 6C0403 790 SA579 JMP (X0304) ;crunch tokens (normally A57C)
    791 ;
    792 ;crunch tokens routine
    793 ;
A57C A67A 794     LDX Z7A      ;get input index
A57E A004 795     LDY $04       ;set output index -5
A580 840F 796     STY ZOF      ;set not a DATA statement
A582 BD0002 797 BA582 LDA X0200,X ;get next character
A585 1007 798     BPL BA58E
A587 C9FF 799     CMP $FF      ;check for PI
A589 F03E 800     BEQ BA5C9
A58B E8 801     INX
A58C D0F4 802     BNE BA582
A58E C920 803 BA58E CMP $20      ;move blanks
A590 F037 804     BEQ BA5C9
A592 8508 805     STA Z08      ;save possible quote
A594 C922 806     CMP `"
A596 F056 807     BEQ BA5EE      ;move string when between quotes
A598 240F 808     BIT ZOF      ;move character if in DATA statement
A59A 702D 809     BVS BA5C9
A59C C93F 810     CMP $3F      ;if question mark
A59E D004 811     BNE BA5A4
A5A0 A999 812     LDA $99      ;replace by code for PRINT
A5A2 D025 813     BNE BA5C9
A5A4 C930 814 BA5A4 CMP `O      ;move if numeric
A5A6 9004 815     BCC BA5AC
A5A8 C93C 816     CMP $3C
A5AA 901D 817     BCC BA5C9
A5AC 8471 818 BA5AC STY Z71      ;save output index
A5AE A000 819     LDY $00      ;initialize table index
A5B0 840B 820     STY Z0B      ;initialize keyword count
A5B2 88 821     DEY
A5B3 867A 822     STX Z7A      ;save input index
A5B5 CA 823     DEX
A5B6 C8 824 BA5B6 INY      ;next character in table
A5B7 E8 825     INX      ;next character in line
A5B8 BD0002 826 BA5B8 LDA X0200,X ;get character from input buffer
A5B8 38 827     SEC
A5BC F99EA0 828     SBC TA09E,Y ;if equal to table character
A5BF F0F5 829     BEQ BA5B6      ;try next
A5C1 C980 830     CMP $80      ;if equal to character without bit 7
A5C3 D030 831     BNE BA5F5
A5C5 050B 832     ORA Z0B      ;save keyword count + $80
A5C7 A471 833 BA5C7 LDY Z71      ;restore output index
A5C9 E8 834 BA5C9 INX      ;advance input index
A5CA C8 835     INY      ;advance output index
A5CB 99FB01 836     STA X0200-5,Y ;store character or code
A5CE B9FB01 837     LDA X0200-5,Y
A5D1 F036 838     BEQ BA609      ;if zero, end of string
A5D3 38 839     SEC
A5D4 E93A 840     SBC `:      ;if colon, set flag to not data
A5D6 F004 841     BEQ BA5DC
A5D8 C949 842     CMP $49      ;if code for DATA, set flag
A5DA D002 843     BNE BA5DE
A5DC 850F 844 BA5DC STA Z0F
A5DE 38 845 BA5DE SEC
A5DF E955 846     SBC $55      ;if REM
A5E1 D09F 847     BNE BA582
A5E3 8508 848     STA Z08      ;set 00 as terminator
A5E5 BD0002 849 BA5E5 LDA X0200,X ;get next character from input buffer

```

A5E8 F0DF	850	BEQ BA5C9	;end upon zero
A5EA C508	851	CMP Z08	
A5EC F0DB	852	BEQ BA5C9	;or terminator ("")
A5EE C8	853	BA5EE INY	;advance output index
A5EF 99FB01	854	STA X0200-5,Y	;move character
A5F2 E8	855	INX	;advance input index
A5F3 DOFO	856	BNE BA5E5	;repeat
A5F5 A67A	857	BA5F5 LDX Z7A	;at end of keyword from table
A5F7 E60B	858	INC Z0B	;increment count
A5F9 C8	859	BA5F9 INY	;advance table pointer
A5FA B99DAO	860	LDA TA09E-1,Y	;beyond end of last keyword
A5FD 10FA	861	BPL BA5F9	
A5FF B99EA0	862	LDA TA09E,Y	;if not at end of table
A602 DOB4	863	BNE BA5B8	
A604 BD0002	864	LDA X0200,X	;restore input character
A607 10BE	865	BPL BA5C7	;repeat
A609 99FD01	866	BA609 STA X0200-3,Y	;set end of line
A60C C67B	867	DEC Z7B	;set current character pointer
A60E A9FF	868	LDA \$FF	
A610 857A	869	STA Z7A	;to beginning of input buffer again
A612 60	870	RTS	

```

872 ;search for a statement in the program
873 ;
874 ;line number search argument in Z14/Z15
875 ;exit with C=1/0 for found/not found
876 ;Z5F/Z60 set to address of statement found, or next higher
877 ;
A613 A52B 878 SA613 LDA Z2B      ;get pointer to beginning of BASIC
A615 A62C 879 LDX Z2C
A617 A001 880 BA617 LDY $01
A619 855F 881 STA Z5F      ;save pointer to current statement
A61B 8660 882 STX Z60
A61D B15F 883 LDA (Z5F),Y ;get link address in current statement
A61F F01F 884 BEQ BA640    ;0=end of program
A621 C8   885 INY
A622 C8   886 INY
A623 A515 887 LDA Z15
A625 D15P 888 CMP (Z5F),Y ;compare statement numbers
A627 9018 889 BCC BA641    ;return if search high (not found)
A629 F003 890 BEQ BA62E    ;since high matches, check low
A62B 88   891 DEY
A62C D009 892 BNE BA637    ;continue since statement number low
A62E A514 893 BA62E LDA Z14
A630 88   894 DEY
A631 D15F 895 CMP (Z5F),Y ;compare low order of statement numbers
A633 900C 896 BCC BA641    ;return if high
A635 F00A 897 BEQ BA641    ;return if equal
A637 88   898 BA637 DEY
A638 B15F 899 LDA (Z5F),Y ;get pointer to next statement in AY
A63A AA   900 TAX
A63B 88   901 DEY
A63C B15F 902 LDA (Z5F),Y
A63E B0D7 903 BCS BA617    ;repeat
A640 18   904 BA640 CLC
A641 60   905 BA641 RTS

```

```

907 ;"NEW" command
908 ;
A642 DOFD 909 WA642 BNE BA641 ;if parameters present, SYNTAX Error
A644 A900 910 LDA $00
A646 A8 911 TAY
A647 912 STA (Z2B),Y ;store zero's
A649 C8 913 INY
A64A 912B 914 STA (Z2B),Y ;in first 2 bytes of BASIC program area
A64C A52B 915 LDA Z2B ;pointer to start of BASIC
A64E 18 916 CLC
A64F 6902 917 ADC $02 ;+ 2
A651 852D 918 STA Z2D ;becomes pointer to end of BASIC
A653 A52C 919 LDA Z2C
A655 6900 920 ADC $00
A657 852E 921 STA Z2E
A659 208EA6 922 SA659 JSR SA68E ;re-initialize current character ptr
A65C A900 923 LDA $00 ;Z = 1
924 ;
925 ;"CLR" command
926 ;
A65E D02D 927 WA65E BNE BA68D ;if parameters present, SYNTAX Error
A660 20E7FF 928 SA660 JSR XFFE7 ;close all channels and files
A663 A537 929 LDA Z37 ;get memory limit in AY
A665 A438 930 LDY Z38
A667 8533 931 STA Z33 ;reset string storage pointer
A669 8434 932 STY Z34
A66B A52D 933 LDA Z2D ;move pointer to variables in AY
A66D A42E 934 LDY Z2E
A66F 852F 935 STA Z2F ;into pointer to start of arrays
A671 8430 936 STY Z30
A673 8531 937 STA Z31 ;also into pointer to end of arrays
A675 8432 938 STY Z32
A677 201DA8 939 JSR SA81D ;perform RESTORE
940 ;
941 ;reset stack and program pointers
942 ;
A67A A219 943 SA67A LDX <Z19
A67C 8616 944 STX Z16 ;reset string descriptor stack index
A67E 68 945 PLA ;get own return address in AY
A67F A8 946 TAY
A680 68 947 PLA
A681 A2FA 948 LDX $FA ;reset stack pointer
A683 9A 949 TXS ;put own return address back on stack
A684 48 950 PHA
A685 98 951 TYA
A686 48 952 PHA
A687 A900 953 LDA $00
A689 853E 954 STA Z3E ;clear pointer for CONTinue
A68B 8510 955 STA Z10 ;also subscript flag
A68D 60 956 BA68D RTS

```

```

      958 ;set current character pointer to beginning of program -1
      959 ;
A68E 18    960 SA68E CLC
A68F A52B   961 LDA Z2B      ;get pointer to beginning of BASIC area
A691 69FF   962 ADC $FF     ;-1
A693 857A   963 STA Z7A      ;store into current character pointer
A695 A52C   964 LDA Z2C      ;same for high byte
A697 69FF   965 ADC $FF
A699 857B   966 STA Z7B
A69B 60     967 RTS
      968 ;
      969 ;"LIST" command
      970 ;
A69C 9006   971 WA69C BCC BA6A4 ;parameter must be numeric,
A69E F004   972 BEQ BA6A4 ;or else none at all
A6A0 C9AB   973 CMP $AB ;or "-"
A6A2 D0E9   974 BNE BA68D ;if none of above, SYNTAX Error
A6A4 206BA9 975 BA6A4 JSR SA96B ;gather decimal number into Z14/Z15
A6A7 2013A6 976 JSR SA613 ;search for statement in program
A6AA 207900 977 JSR X0079 ;get current character
A6AD F00C   978 BEQ BA6BB ;if not at end of statement
A6AF C9AB   979 CMP $AB ;or "-"
A6B1 D08E   980 BNE BA641 ;then SYNTAX Error
A6B3 207300 981 JSR X0073 ;get next character after "-"
A6B6 206BA9 982 JSR SA96B ;gather decimal number into Z14/Z15
A6B9 D086   983 BNE BA641 ;if not end of statement, SYNTAX Error
A6BB 68     984 BA6BB PLA ;remove return address from stack
A6BC 68     985 PLA
A6BD A514   986 LDA Z14 ;if last parameter zero (missing)
A6BF 0515   987 ORA Z15
A6C1 D006   988 BNE BA6C9
A6C3 A9FF   989 LDA $FF
A6C5 8514   990 STA Z14 ;set it to 65535
A6C7 8515   991 STA Z15

```

```

993 ;list statement from Z5F/Z60 thru Z14/Z15
994 ;
A6C9 A001 995 BA6C9 LDY $01      ;set string switch to not a string
A6CB 840F 996 STY ZOF
A6CD B15F 997 LDA (Z5F),Y ;get high byte of link address for line
A6CF F043 998 BEQ BA714 ;0=end of program, go restart BASIC
A6D1 202CA8 999 JSR SA82C ;check for Stop Key
A6D4 20D7AA 1000 JSR SAAD7 ;end line on CMD output file
A6D7 C8 1001INY
A6D8 B15F 1002LDA (Z5F),Y
A6DA AA 1003TAX
A6DB C8 1004INY
A6DC B15F 1005LDA (Z5F),Y
A6DE C515 1006CMP Z15
A6EO D004 1007BNE BA6E6
A6E2 E414 1008CPX Z14
A6E4 F002 1009BEQ BA6E8
A6E6 B02C 1010BA6E6BCS BA714
A6E8 8449 1011BA6E8STY Z49
A6EA 20CDBD 1012JSR SBDCCD
A6ED A920 1013LDA $20
A6EF A449 1014BA6EFLDY Z49
A6F1 297F 1015AND $7F
A6F3 2047AB 1016BA6F3JSR SAB47
A6F6 C922 1017CMP ""
A6F8 D006 1018BNE BA700
A6FA A50F 1019LDA ZOF
A6FC 49FF 1020EOR $FF
A6FE 850F 1021STA ZOF
A700 C8 1022BA700INY
A701 F011 1023BEQ BA714
A703 B15F 1024LDA (Z5F),Y
A705 D010 1025BNE BA717
A707 A8 1026TAY
A708 B15F 1027LDA (Z5F),Y
A70A AA 1028TAX
A70B C8 1029INY
A70C B15F 1030LDA (Z5F),Y
A70E 865F 1031STX Z5F
A710 8560 1032STA Z60
A712 D0B5 1033BNE BA6C9
A714 4C86E3 1034BA714JMP XE386
;then loop back for next line
;go restart BASIC

```

```

A717 6C0603 1036 BA717 JMP (X0306) ;go print tokens (normally A71A)
1037 ;
1038 ;print tokens
1039 ;
A71A 10D7 1040      BPL BA6F3    ;if bit 7 clear, print one character
A71C C9FF 1041      CMP $FF     ;if code for PI,
A71E F0D3 1042      BEQ BA6F3    ;print PI
A720 240F 1043      BIT ZOF     ;if in string mode
A722 30CF 1044      BMI BA6F3    ;also print shifted codes
A724 38   1045      SEC
A725 E97F 1046      SBC $7F     ;compute keyword #
A727 AA   1047      TAX
A728 8449 1048      STY Z49     ;save index in statement
A72A A0FF 1049      LDY $FF
A72C CA   1050 BA72C DEX    ;if keyword found
A72D F008 1051      BEQ BA737  ;go print keyword
A72F C8   1052 BA72F INY
A730 B99EA0 1053     LDA TA09E,Y ;else get character from keyword table
A733 10FA 1054      BPL BA72F
A735 30F5 1055      BMI BA72C  ;until bit 7 set (end of keyword)
1056 ;
1057 ;print keyword
1058 ;
A737 C8   1059 BA737 INY
A738 B99EA0 1060     LDA TA09E,Y ;get next character from keyword table
A73B 30B2 1061      BMI BA6EF   ;if bit 7 set go print last character
A73D 2047AB 1062    JSR SAB47  ;print character on CMD file
A740 DOF5 1063      BNE BA737  ;and repeat

```

```

1065 ;"FOR" command
1066 ;
A742 A980 1067 WA742 LDA $80      ;set flag for
A744 8510 1068 STA Z10           ;no integer variables or array elements
A746 20A5A9 1069 JSR SA9A5       ;execute command LET
A749 208AA3 1070 JSR SA38A       ;get FOR block of variable used
A74C D005 1071 BNE BA753
A74E 8A 1072 TXA
A74F 690F 1073 ADC $0F          ;if found,
A751 AA 1074 TAX
A752 9A 1075 TXS
A753 68 1076 BA753 PLA        ;remove return address from stack
A754 68 1077 PLA
A755 A909 1078 LDA $09          ;9 addresses on stack needed
A757 20FBAA 1079 JSR SA3FB       ;else OUT OF MEMORY Error
A75A 2006A9 1080 JSR SA906       ;get offset to end of statement
A75D 18 1081 CLC
A75E 98 1082 TYA
A75F 657A 1083 ADC Z7A          ;compute pointer to end of statement
A761 48 1084 PHA
A762 A57B 1085 LDA Z7B
A764 6900 1086 ADC $00
A766 48 1087 PHA               ;save on stack
A767 A53A 1088 LDA Z3A
A769 48 1089 PHA
A76A A539 1090 LDA Z39          ;save current statement # on stack
A76C 48 1091 PHA
A76D A9A4 1092 LDA $A4
A76F 20FFAE 1093 JSR SAEFF       ;if not T0, then SYNTAX Error
A772 208DAD 1094 JSR SAD8D       ;initial value must be non-string
A775 208AAD 1095 JSR SAD8A       ;get next non-string value (T0 value)
A778 A566 1096 LDA Z66
A77A 097F 1097 ORA $7F
A77C 2562 1098 AND Z62          ;move sign of flp accu
A77E 8562 1099 STA Z62          ;into most significant bit
A780 A98B 1100 LDA <WA78B
A782 A0A7 1101 LDY >WA78B
A784 8522 1102 STA Z22          ;set return address for continuation
A786 8423 1103 STY Z23
A788 4C43AE 1104 JMP JAE43       ;round and save flp accu (T0 value)
A788 4C43AE 1105 ;                ;set AY to default step (1)
A78B A9BC 1106 WA78B LDA <TB9BC
A78D A0B9 1107 LDY >TB9BC
A78F 20A2BB 1108 JSR SBBA2       ;load default step
A792 207900 1109 JSR X0079       ;get next character
A795 C9A9 1110 CMP $A9          ;if STEP
A797 D006 1111 BNE BA79F
A799 207300 1112 JSR X0073       ;get next character
A79C 208AAD 1113 JSR SAD8A       ;get next non-string value
A79F 202BBC 1114 BA79F JSR SBC2B
A7A2 2038AE 1115 JSR SAE38       ;get SGN of flp accu
A7A5 A54A 1116 LDA Z4A          ;round flp accu and save on stack
A7A7 48 1117 PHA
A7A8 A549 1118 LDA Z49
A7AA 48 1119 PHA
A7AB A981 1120 LDA $81          ;save code for FOR block
A7AD 48 1121 PHA

```

```

1123 ;execute next statement
1124 ;
A7AE 202CA8 1125 JA7AE JSR SA82C ;check Stop Key
A7B1 A57A 1126 LDA Z7A
A7B3 A47B 1127 LDY Z7B ;get ptr to end of old statement in AY
A7B5 C002 1128 CPY $02
A7B7 EA 1129 NOP
A7B8 F004 1130 BEQ BA7BE ;if not direct mode,
A7BA 853D 1131 STA Z3D ;store pointer for possible CONT
A7BC 843E 1132 STY Z3E
A7BE A000 1133 BA7BE LDY $00
A7C0 B17A 1134 LDA (Z7A),Y ;get last byte
A7C2 D043 1135 BNE BA807 ;if not 0, check for ":""
A7C4 A002 1136 LDY $02
A7C6 B17A 1137 LDA (Z7A),Y ;get high of pointer to next statement
A7C8 18 1138 CLC
A7C9 D003 1139 BNE BA7CE
A7CB 4C4BA8 1140 JMP JA84B ;0=end of program
1141 ;
A7CE C8 1142 BA7CE INY
A7CF B17A 1143 LDA (Z7A),Y ;move statement # into Z39/Z3A
A7D1 8539 1144 STA Z39
A7D3 C8 1145 INY
A7D4 B17A 1146 LDA (Z7A),Y
A7D6 853A 1147 STA Z3A
A7D8 98 1148 TYA ;advance pointer over statement header
A7D9 657A 1149 ADC Z7A
A7DB 857A 1150 STA Z7A
A7DD 9002 1151 BCC JA7E1
A7DF E67B 1152 INC Z7B
A7E1 6C0803 1153 JA7E1 JMP (X0308) ;go execute a statement (normally A7E4)
1154 ;
1155 ;execute a statement
1156 ;
A7E4 207300 1157 JSR X0073 ;get next character
A7E7 20EDA7 1158 JSR SA7ED ;execute command in A
A7EA 4CAEA7 1159 JMP JA7AE ;go execute next statement

```

```

1161 ;execute command in A
1162 ;
A7ED F03C 1163 SA7ED BEQ BA82B      ;if Z = 1, return (dummy statement)
A7EF E980 1164 JA7EF SBC $80        ;if A < $80
A7F1 9011 1165 BCC BA804          ;perform LET
A7F3 C923 1166 CMP $23            ;if A = > A3 (highest command)
A7F5 B017 1167 BCS BA80E          ;then check for GOTO
A7F7 OA   1168 ASL A              ;get 2 * (A - 80) as index to table
A7F8 A8   1169 TAY
A7F9 B90DAO 1170 LDA TA00C+1,Y ;move routine address onto stack
A7FC 48   1171 PHA
A7FD B90CA0 1172 LDA TA00C,Y
A800 48   1173 PHA
A801 4C7300 1174 JMP X0073      ;get first char of parameters and go
1175 ;
A804 4CA5A9 1176 BA804 JMP SA9A5  ;execute command LET
1177 ;
A807 C93A 1178 BA807 CMP `:       ;if character is a colon,
A809 F0D6 1179 BEQ JA7E1        ;execute next command
A80B 4C08AF 1180 BA80B JMP JAFO8 ;else print SYNTAX Error
1181 ;
A80E C94B 1182 BA80E CMP $4B      ;if not code for GO
A810 D0F9 1183 BNE BA80B        ;then SYNTAX Error
A812 207300 1184 JSR X0073      ;else get next character
A815 A9A4 1185 LDA $A4          ;set code for TO
A817 20FFAE 1186 JSR SAEFF      ;if equal
A81A 4CA0A8 1187 JMP JA8AO      ;go do command GOTO

```

```

1189 ;"RESTORE" command
1190 ;
A81D 1191 WA81D = *
A81D 38 1192 SA81D SEC
A81E A52B 1193 LDA Z2B      ;get pointer to beginning of BASIC
A820 E901 1194 SBC $01      ;-1
A822 A42C 1195 LDY Z2C      ;into AY
A824 B001 1196 BCS BA827
A826 88   1197 DEY
A827 8541 1198 BA827 STA Z41 ;store AY in current DATA address
A829 8442 1199 STY Z42
A82B 60   1200 BA82B RTS
1201 ;
A82C 20E1FF 1202 SA82C JSR XFFE1 ;test Stop Key
1203 ;
1204 ;"STOP" command
1205 ;
A82F B001 1206 WA82F BCS BA832 ;preserve C flag
1207 ;
1208 ;"END" command
1209 ;
A831 18   1210 WA831 CLC ;clear C flag
A832 D03C 1211 BA832 BNE BA870 ;if parameters present, SYNTAX Error
A834 A57A 1212 LDA Z7A ;set AY to address of current line
A836 A47B 1213 LDY Z7B
A838 A63A 1214 LDX Z3A
A83A E8   1215 INX
A83B F00C 1216 BEQ BA849 ;if not in direct mode,
A83D 853D 1217 STA Z3D ;save pointer for possible CONT
A83F 843E 1218 STY Z3E
A841 A539 1219 LDA Z39 ;AY=current statement #
A843 A43A 1220 LDY Z3A
A845 853B 1221 STA Z3B ;move current statement #
A847 843C 1222 STY Z3C ;to previous statement #
A849 68   1223 BA849 PLA ;remove own return address
A84A 68   1224 PLA
A84B A981 1225 JA84B LDA <TA381 ;set AY to BREAK message
A84D A0A3 1226 LDY >TA381
A84F 9003 1227 BCC BA854 ;if STOP command,
A851 4C69A4 1228 JMP JA469 ;print message and restart BASIC
A854 4C86E3 1229 BA854 JMP XE386 ;else restart BASIC

```

```

        1231 ;"CONT" command
        1232 ;
A857 D017 1233 WA857 BNE BA870      ;if parameters present, SYNTAX Error
A859 A21A 1234 LDX $1A             ;point to message CAN'T CONTINUE
A85B A43E 1235 LDY Z3E            ;get pointer to current statement in AY
A85D D003 1236 BNE BA862          ;if pointer=0,
A85F 4C37A4 1237 JMP JA437        ;fatal error

        1238 ;
A862 A53D 1239 BA862 LDA Z3D      ;move saved character pointer
A864 857A 1240 STA Z7A            ;into current character pointer
A866 847B 1241 STY Z7B            ;move previous statement #
A868 A53B 1242 LDA Z3B            ;into current statement #
A86A A43C 1243 LDY Z3C
A86C 8539 1244 STA Z39
A86E 843A 1245 STY Z3A
A870 60   1246 BA870 RTS
        1247 ;
        1248 ;"RUN" command
        1249 ;

A871 08   1250 WA871 PHP
A872 A900 1251 LDA $00
A874 2090FF 1252 JSR XFF90      ;set kernal messages flag to RUN mode
A877 28   1253 PLP
A878 D003 1254 BNE BA87D          ;if no parameters,
A87A 4C59A6 1255 JMP SA659        ;do CLR and start program
        1256 ;
A87D 2060A6 1257 BA87D JSR SA660 ;else do CLR and then
A880 4C97A8 1258 JMP JA897        ;do GOTO
        1259 ;
        1260 ;"GOSUB" command
        1261 ;

A883 A903 1262 WA883 LDA $03      ;need 3 address on stack
A885 20FBAA 1263 JSR SA3FB        ;else error OUT OF MEMORY
A888 A57B 1264 LDA Z7B
A88A 48   1265 PHA
A88B A57A 1266 LDA Z7A          ;save pointer to current character
A88D 48   1267 PHA              ;on the stack
A88E A53A 1268 LDA Z3A
A890 48   1269 PHA
A891 A539 1270 LDA Z39
A893 48   1271 PHA              ;save current statement # on stack
A894 A98D 1272 LDA $8D
A896 48   1273 PHA              ;save code for GOSUB
A897 207900 1274 JA897 JSR X0079 ;get current character
A89A 20A0A8 1275 JSR JA8A0        ;execute command GOTO
A89D 4CAEA7 1276 JMP JA7AE        ;execute next statement

```

```

1278 ;"COTO" command
1279 ;
A8A0 1280 WA8A0 = *
A8A0 206BA9 1281 JA8A0 JSR SA96B ;gather decimal number into Z14/Z15
A8A3 2009A9 1282 JSR SA909 ;get offset to end of line in Y
A8A6 38 1283 SEC
A8A7 A539 1284 LDA Z39 ;fetch current statement number
A8A9 E514 1285 SBC Z14
A8AB A53A 1286 LDA Z3A
A8AD E515 1287 SBC Z15 ;if forward jump,
A8AF B00B 1288 BCS BA8BC ;let current character pointer
A8B1 98 1289 TYA ;point to next statement
A8E2 38 1290 SEC
A8B3 657A 1291 ADC Z7A
A8B5 A67B 1292 LDX Z7B ;also start search there
A8B7 9007 1293 BCC BA8C0
A8B9 E8 1294 INX
A8BA B004 1295 BCS BA8C0
A8BC A52B 1296 BA&BC LDA Z2B ;else start at beginning of BASIC
A8BE A62C 1297 LDX Z2C
A8C0 2017A6 1298 BA8C0 JSR BA617 ;search for statement starting at AX
A8C3 901E 1299 BCC BA8E3 ;if not found, UNDEF'D STATEMENT
A8C5 A55F 1300 LDA Z5F ;move pointer to statement found
A8C7 E901 1301 SBC $01 ;-1
A8C9 857A 1302 STA Z7A ;into current character pointer
A8CB A560 1303 LDA Z60
A8CD E900 1304 SBC $00
A8CF 857B 1305 STA Z7B
A8D1 60 1306 BA8D1 RTS
1307 ;
1308 ;"RETURN" command
1309 ;
A8D2 D0FD 1310 WA8D2 BNE BA8D1 ;if parameters present, SYNTAX Error
A8D4 A9FF 1311 LDA $FF
A8D6 854A 1312 STA Z4A
A8D8 208AA3 1313 JSR SA38A ;get FOR block
A8DB 9A 1314 TXS ;remove everything above current block
A8DC C98D 1315 CMP $8D ;and the block found must be a COSUB
A8DE F00B 1316 BEQ BA8EB
A8E0 A20C 1317 LDX $0C ;else point to RETURN WITHOUT GOSUB
A8E2 2C 1318 .BY $2C ;skip next instruction
A8E3 A211 1319 BA8E3 LDX $11 ;point to UNDEF'D STATEMENT message
A8E5 4C37A4 1320 JMP JA437 ;go print error message
1321 ;
A8E8 4C08AF 1322 BA8E8 JMP JAF08 ;print SYNTAX Error message
1323 ;
A8EB 68 1324 BA8EB PLA ;remove COSUB block from stack
A8EC 68 1325 PLA
A8ED 8539 1326 STA Z39 ;remove statement number
A8EF 68 1327 PLA
A8FO 853A 1328 STA Z3A
A8F2 68 1329 PLA
A8F3 857A 1330 STA Z7A ;restore current character pointer
A8F5 68 1331 PLA
A8F6 857B 1332 STA Z7B

```

```

1334 ;"DATA" command
1335 ;
A8F8 1336 WA8F8 = *
A8F8 2006A9 1337 JA8F8 JSR SA906 ;get offset to next ":" 
A8FB 98 1338 BA8FB TYA
A8FC 18 1339 CLC
A8FD 657A 1340 ADC Z7A ;add offset to current character pointer
A8FF 857A 1341 STA Z7A ;(skips statement)
A901 9002 1342 BCC BA905
A903 E67B 1343 INC Z7B
A905 60 1344 BA905 RTS
1345 ;
1346 ;get end of statement (":" SA906)
1347 ;get end of line (00, SA909)
1348 ;
A906 A23A 1349 SA906 LDX `: ;set statement separator
A908 2C 1350 .BY $2C ;skip next instruction
A909 A200 1351 SA909 LDX $00 ;set line separator
A90B 8607 1352 STX Z07 ;save separator character
A90D A000 1353 LDY $00
A90F 8408 1354 STY Z08 ;save alternate separator
A911 A508 1355 BA911 LDA Z08
A913 A607 1356 LDX Z07
A915 8507 1357 STA Z07 ;swap separators
A917 8608 1358 STX Z08
A919 B17A 1359 BA919 LDA (Z7A),Y ;get next character
A91B FOE8 1360 BEQ BA905 ;if end of line
A91D C508 1361 CMP Z08 ;or separator reached
A91F FOE4 1362 BEQ BA905 ;exit with Y=length scanned
A921 C8 1363 INY ;else advance pointer
A922 C922 1364 CMP `" ;if character = quote
A924 D0F3 1365 BNE BA919 ;swap separators and continue
A926 FOE9 1366 BEQ BA911 ;continue
1367 ;
1368 ;"IF" command
1369 ;
A928 209EAD 1370 WA928 JSR SAD9E ;evaluate expression
A92B 207900 1371 JSR X0079 ;get current character
A92E C989 1372 CMP $89 ;if not code for GOTO
A930 F005 1373 BEQ BA937
A932 A9A7 1374 LDA $A7 ;or code for THEN
A934 20FFAE 1375 JSR SAEFF ;then SYNTAX Error
A937 A561 1376 BA937 LDA Z61 ;if result of condition true, do action
A939 D005 1377 BNE BA940 ;else skip by dropping through to REM

```

```

1379 ;"REM" command
1380 ;
A93B 2009A9 1381 WA93B JSR SA909 ;get offset to end of line
A93E F0BB 1382 BEQ BA8FB ;go advance current character pointer
1383 ;
1384 ;THEN part of IF
1385 ;
A940 207900 1386 BA940 JSR X0079 ;get current character
A943 B003 1387 BCS BA948 ;if numeric
A945 4CA0A8 1388 JMP JA8AO ;then execute command GOTO
A948 4CEDA7 1389 BA948 JMP SA7ED ;else execute command in A
1390 ;
1391 ;"ON" command
1392 ;
A94B 209EB7 1393 WA94B JSR SB79E ;get next integer value into X
A94E 48 1394 PHA ;save current character
A94F C98D 1395 CMP $8D ;if not GOSUB
A951 F004 1396 BEQ BA957 ;or GOTO
A953 C989 1397 BA953 CMP $89 ;then SYNTAX Error
A955 D091 1398 BNE BA8E8 ;decrement index
A957 C665 1399 BA957 DEC Z65 ;if zero
A959 D004 1400 BNE BA95F ;restore GOTO or GOSUB code in A
A95B 68 1401 PLA ;and execute command in A
A95C 4CEFA7 1402 JMP JA7EF ;else get next character
A95F 207300 1403 BA95F JSR X0073 ;gather decimal number into Z14/Z15
A962 206BA9 1404 JSR SA96B ;if ends with a comma
A965 C92C 1405 CMP ',' ;then repeat
A967 FOEE 1406 BEQ BA957 ;else must be end of statement
A969 68 1407 PLA ;otherwise force SYNTAX Error
A96A 60 1408 BA96A RTS

```

```

1410 ;gather decimal number into Z14/Z15
1411 ;
1412 ;gathered from current statement
1413 ;expects A, C and Z to reflect current character
1414 ;returns with A, C and Z reflecting new
1415 ;current character (first character after number)
1416 ;
A96B A200 1417 SA96B LDX $00      ;set answer area to zero
A96D 8614 1418 STX Z14
A96F 8615 1419 STX Z15
A971 BOF7 1420 JA971 BCS BA96A    ;stop at first non-decimal character
A973 E92F 1421 SBC $2F      ;convert decimal to binary
A975 8507 1422 STA Z07      ;save it
A977 A515 1423 LDA Z15
A979 8522 1424 STA Z22      ;save old high order
A97B C919 1425 CMP $19      ;if # gathered so far >= 6400
A97D B0D4 1426 BCS BA953    ;then SYNTAX Error
A97F A514 1427 LDA Z14
A981 0A   1428 ASL A       ;* 2
A982 2622 1429 ROL Z22
A984 0A   1430 ASL A       ;* 4
A985 2622 1431 ROL Z22
A987 6514 1432 ADC Z14      ;+ original = * 5
A989 8514 1433 STA Z14
A98B A522 1434 LDA Z22
A98D 6515 1435 ADC Z15
A98F 8515 1436 STA Z15
A991 0614 1437 ASL Z14      ;* 2 = * 10
A993 2615 1438 ROL Z15
A995 A514 1439 LDA Z14
A997 6507 1440 ADC Z07      ;add new digit
A999 8514 1441 STA Z14
A99B 9002 1442 BCC BA99F
A99D E615 1443 INC Z15
A99F 207300 1444 BA99F JSR X0073  ;get next character
A9A2 4C71A9 1445 JMP JA971  ;and repeat

```

```

1447 ;"LET" command
1448 ;
A9A5 1449 WA9A5 = *
A9A5 208BB0 1450 SA9A5 JSk SB08B ;gather name and get ptr to variable
A9A8 8549 1451 STA Z49 ;save variable pointer
A9AA 844A 1452 STY Z4A
A9AC A9B2 1453 LDA $B2 ;load code for "="
A9AE 20FAE 1454 JSR SAEFF ;must be next character
A9B1 A50E 1455 LDA ZOE
A9B3 48 1456 PHA ;save integer flag of variable
A9B4 A50D 1457 LDA ZOD
A9B6 48 1458 PHA ;save string flag of variable
A9B7 209EAD 1459 JSR SAD9E ;evaluate expression
A9BA 68 1460 PLA ;restore string flag of variable
A9BB 2A 1461 ROL A ;also into C flag
A9BC 2090AD 1462 JSR SAD90 ;check value for same type
A9EF D018 1463 BNE BA9D9 ;branch if string to be assigned
A9C1 68 1464 PLA ;restore integer flag of variable
A9C2 1012 1465 SA9C2 BPL BA9D6 ;branch if flp accu to be stored
1466 ;
1467 ;assign to integer
1468 ;
A9C4 201BBC 1469 JSR SBC1B ;round flp accu according to guard bit
A9C7 20BF01 1470 JSR SBLBF ;convert flp accu to integer
A9CA A000 1471 LDY $00
A9CC A564 1472 LDA Z64 ;get most significant byte of integer
A9CE 9149 1473 STA (Z49),Y ;store into + 0 of variable
A9D0 C8 1474 INY
A9D1 A565 1475 LDA Z65 ;get least significant byte of integer
A9D3 9149 1476 STA (Z49),Y ;store into + 1 of variable
A9D5 60 1477 RTS
1478 ;
1479 ;assign to flp
1480 ;
A9D6 4CDOBB 1481 BA9D6 JMP JBB0 ;go store flp value
1482 ;
1483 ;assign to string
1484 ;
A9D9 68 1485 BA9D9 PLA ;remove integer flag from stack
A9DA A44A 1486 SA9DA LDY Z4A ;if high byte of pointer to variable
A9DC COBF 1487 CPY $BF ;not same as address of dummy variable
A9EE D04C 1488 BNE BAA2C ;then go do normal variable

```

```

1490 ;assign to TI$  

1491 ;  

A9E0 20A6B6 1492      JSR SB6A6      ;de-allocate temporary string  

A9E3 C906 1493      CMP $06       ;should be 6 characters long  

A9E5 D03D 1494      BNE BAA24     ;else ILLEGAL QUANTITY Error  

A9E7 A000 1495      LDY $00       ;store 0 in flp accu  

A9E9 8461 1496      STY Z61       ;  

A9EB 8466 1497      STY Z66       ;  

A9ED 8471 1498      BA9ED STY Z71  ;set index in string  

A9EF 201DAA 1499      JSR SAA1D     ;add next digit to flp accu  

A9F2 20E2BA 1500      JSR SBAE2     ;multiply flp accu by 10  

A9F5 E671 1501      INC Z71       ;increment index  

A9F7 A471 1502      LDY Z71       ;  

A9F9 201DAA 1503      JSR SAA1D     ;add next digit to flp accu  

A9FC 200CBC 1504      JSR SBC0C     ;move rounded flp accu to 2nd flp accu  

A9FF AA 1505      TAX          ;get exponent  

AA00 F005 1506      BEQ BAA07     ;if zero, skip next multiplication  

AA02 E8 1507      INX          ;increment exponent  

AA03 8A 1508      TXA          ;*2 in second flp accu  

AA04 20EDBA 1509      JSR SBAED     ;add 2nd flp accu to flp accu and *2  

AA07 A471 1510      BAA07 LDY Z71  ;get index  

AA09 C8 1511      INY          ;repeat until 6 characters processed  

AA0A C006 1512      CPY $06       ;  

AA0C D0DF 1513      BNE BA9ED     ;  

AA0E 20E2BA 1514      JSR SBAE2     ;multiply flp accu by 10  

AA11 209BBC 1515      JSR SBC9B     ;convert flp accu to 4 byte integer  

AA14 A664 1516      LDX Z64       ;  

AA16 A463 1517      LDY Z63       ;  

AA18 A565 1518      LDA Z65       ;  

AA1A 4CDBFF 1519      JMP XFFDB     ;set real time clock  

1520 ;  

1521 ;add next digit to flp accu  

1522 ;  

AA1D B122 1523      SAA1D LDA (Z22),Y  ;get character from string  

AA1F 208000 1524      JSR X0080     ;check for numeric character  

AA22 9003 1525      BCC BAA27     ;  

AA24 4C48B2 1526      BAA24 JMP JB248  ;ILLEGAL QUANTITY Error if not  

1527 ;  

AA27 E92F 1528      BAA27 SBC $2F     ;convert decimal to binary  

AA29 4C7EBD 1529      JMP JBD7E     ;add signed integer from A to flp accu

```

```

1531 ; assign to normal string variable
1532 ;
AA2C A002 1533 BAA2C LDY $02
AA2E B164 1534 LDA (Z64),Y ; if pointer to string
AA30 C534 1535 CMP Z34
AA32 9017 1536 BCC BAA4B ; below allocated string area
AA34 D007 1537 BNE BAA3D
AA36 88 1538 DEY
AA37 B164 1539 LDA (Z64),Y
AA39 C533 1540 CMP Z33
AA3B 900E 1541 BCC BAA4B ; then move descriptor
AA3D A465 1542 BAA3D LDY Z65
AA3F C42E 1543 CPY Z2E
AA41 9008 1544 BCC BAA4B ; below end of program
AA43 D00D 1545 BNE BAA52 ;(descriptor stack)
AA45 A564 1546 LDA Z64
AA47 C52D 1547 CMP Z2D
AA49 B007 1548 BCS BAA52
AA4B A564 1549 BAA4B LDA Z64 ; then go move descriptor
AA4D A465 1550 LDY Z65
AA4F 4C68AA 1551 JMP JAA68
1552 ;
AA52 A000 1553 BAA52 LDY $00 ;else
AA54 B164 1554 LDA (Z64) Y ;get length of string
AA56 2075B4 1555 JSR SB475 ;allocate area
AA59 A550 1556 LDA Z50 ;store string pointer
AA5B A451 1557 LDY Z51
AA5D 856F 1558 STA Z6F
AA5F 8470 1559 STY Z70
AA61 207AB6 1560 JSR SB67A ;move string into allocated area
AA64 A961 1561 LDA <Z61 ;set AY to new descriptor
AA66 A000 1562 LDY >Z61
1563 ;
1564 ;move descriptor into variable
1565 ;
AA68 8550 1566 JAA68 STA Z50 ;set pointer to descriptor from AY
AA6A 8451 1567 STY Z51
AA6C 20DBB6 1568 JSR SB6DB ;check descriptor stack
AA6F A000 1569 LDY $00
AA71 B150 1570 LDA (Z50),Y ;move descriptor
AA73 9149 1571 STA (Z49),Y ;to variable
AA75 C8 1572 INY
AA76 B150 1573 LDA (Z50),Y
AA78 9149 1574 STA (Z49),Y ;also + 1
AA7A C8 1575 INY
AA7B B150 1576 LDA (Z50),Y
AA7D 9149 1577 STA (Z49),Y ;and + 2
AA7F 60 1578 RTS

```

```

1580 ;"PRINT#" command
1581 ;
AA80 2086AA 1582 WAA80 JSR SAA86 ;execute CMD and PRINT
AA83 4CB5AB 1583 JMP JABBS ;reset CMD output file #
1584 ;
1585 ;"CMD" command
1586 ;
AA86 1587 WAA86 = *
AA86 209EB7 1588 SAA86 JSR SB79E ;get next integer value in X
AA89 F005 1589 BEQ BAA90 ;if more parameters
AA8B A92C 1590 LDA ', ;next parameter must be a comma
AA8D 20FFAE 1591 JSR SAEFF
AA90 08 1592 BAA90 PHP ;save flags
AA91 8613 1593 STX Z13 ;store new CMD file #
AA93 2018E1 1594 JSR XE118 ;select output device
AA96 28 1595 PLP ;restore flags
AA97 4CA0AA 1596 JMP JAAAAO ;execute command PRINT
1597 ;
AA9A 2021AB 1598 BAA9A JSR SAB21 ;print BASIC string from Z22/Z23
AA9D 207900 1599 BAA9D JSR X0079 ;get current character
1600 ;
1601 ;"PRINT" command
1602 ;
AAA0 1603 WAAA0 = *
AAA0 F035 1604 JAAA0 BEQ SAAD7 ;if no parameters, end line on CMD file
AAA2 F043 1605 JAAA2 BEQ BAAE7 ;if end of statement, return
AAA4 C9A3 1606 CMP $A3 ;if TAB(
AAA6 F050 1607 BEQ BAAF8 ;do TAB/SPC routine
AAA8 C9A6 1608 CMP $A6 ;if SPC(
AAAA 18 1609 CLC
AAAB F04B 1610 BEQ BAAF8 ;do TAB/SPC routine
AAAD C92C 1611 CMP ', ;if comma
AAAF F037 1612 BEQ BAAE8 ;go do fixed tab
AAB1 C93B 1613 CMP '; ;if semicolon
AAB3 F05E 1614 BEQ BAB13 ;ignore
AAB5 209EAD 1615 JSR SAD9E ;evaluate expression
AAB8 240D 1616 BIT ZOD ;if string
AABA 30DE 1617 BMI BAA9A ;print BASIC string
AABC 20DBBD 1618 JSR SBDDD ;convert flp accu to string
AABF 2087B4 1619 JSR SB487 ;get descriptor of string in flp accu
AAC2 2021AB 1620 JSR SAB21 ;print BASIC string from Z22/Z23
AAC5 203BAB 1621 JSR SAB3B ;print Cursor Right on CMD output file
AAC8 D0D3 1622 BNE BAA9D ;repeat

```

```

1624 ;end statement in buffer and on screen
1625 ;
1626 ;X=index beyond last byte in buffer
1627 ;
AAC A900 1628 JAACA LDA $00      ;add 00 to statement in buffer
AACC 9D0002 1629 STA X0200,X
AACF A2FF 1630 LDX $FF
AAD1 A001 1631 LDY $01      ;reset index to beginning of statement
AAD3 A513 1632 LDA Z13      ;if CMD output file = default
AAD5 D010 1633 BNE BAAE7    ;then end line on CMD output file
1634 ;
1635 ;end line on CMD output file
1636 ;
AAD7 A90D 1637 SAAD7 LDA $0D      ;print a Return
AAD9 2047AB 1638 JSR SAB47    ;on CMD output file
AADC 2413 1639 BIT Z13      ;if file number < 128
AADE 1005 1640 BPL BAAE5    ;do not add Linefeed
AAEO A90A 1641 LDA $0A      ;else print a Linefeed on CMD file
AAE2 2047AB 1642 JSR SAB47
AAE5 49FF 1643 BAAE5 EOR $FF    ;condition flags
AAE7 60   1644 BAAE7 RTS
1645 ;
1646 ;routine for printing blanks and tabs
1647 ;
1648 ;fixed tabs at BAAE8
1649 ;TAB( & SPC( at BAAF8
1650 ;
AAE8 38   1651 BAAE8 SEC
AAE9 20FOFF 1652 JSR XFFF0    ;read cursor position into XY
AAEC 98   1653 TYA
AAED 38   1654 SEC
AAEE E90A 1655 BAAE8 SBC $0A    ;convert column to modulo 10 (-10 to -1)
AAFO BOFC 1656 BCS BAAE8
AAF2 49FF 1657 EOR $FF      ;complement
AAF4 6901 1658 ADC $01      ;A = # blanks to insert
AAF6 D016 1659 BNE BABOE    ;skip if zero
AAF8 08   1660 BAAF8 PHP    ;save status
AAF9 38   1661 SEC
AAFA 20FOFF 1662 JSR XFFF0    ;read cursor position again
AAFD 8409 1663 STY Z09      ;save column
AAFF 209BB7 1664 JSR SB79B    ;evaluate expression into X
AB02 C929 1665 CMP ")      ;if not ending with ")"
AB04 D059 1666 BNE BAB5F    ;then SYNTAX Error
AB06 28   1667 PLP      ;restore status
AB07 9006 1668 BCC BAB0F    ;if code for TAB(
AB09 8A   1669 TXA      ;get value in A
AB0A E509 1670 SBC Z09      ;subtract current character position
AB0C 9005 1671 BCC BAB13    ;skip if negative
AB0E AA   1672 BABOE TAX
AB0F E8   1673 BABOF INX
AB10 CA   1674 BAB10 DEX
AB11 D006 1675 BNE BAB19    ;if zero
AB13 207300 1676 BAB13 JSR X0073    ;get next character
AB16 4CA2AA 1677 JMP JAAA2    ;return to PRINT
AB19 203BAB 1678 BAB19 JSR SAB3B    ;print Cursor Right on CMD output file
AB1C D0F2 1679 BNE BAB10    ;X times

```

```

1681 ;print string from AY
1682 ;
AB1E 2087B4 1683 SAB1E JSR SB487      ;move string descriptor into flp accu
1684 ;
1685 ;print BASIC string from Z22/Z23
1686 ;
AB21 20A6B6 1687 SAB21 JSR SB6A6      ;get text pointer into Z22/Z23
AB24 AA    1688     TAX               ;save string length
AB25 A000  1689     LDY $00
AB27 E8    1690     INX
AB28 CA    1691 BAB28 DEX          ;decrement length pending
AB29 F0BC  1692 BEQ BAAE.        ;exit upon completion
AB2B B122  1693 LDA (Z22),Y      ;get next character
AB2D 2047AB 1694 JSR SAB47        ;print it on CMD output file
AE30 C8    1695 INY             ;advance pointer
AB31 C90D  1696 CMP $0D          ;if character printed was a Return
AB33 D0F3  1697 BNE BAB28
AB35 20E5AA 1698 JSR BAAE5        ;then do dummy instruction
AB38 4C28AB 1699 JMP BAB28        ;repeat
1700 ;
1701 ;print a character on CMD output file
1702 .
AB3B A513  1703 SAB3B LDA Z13      ;if CMD output file is default
AB3D F003  1704 BEQ BAB42        ;print Cursor Right
AB3F A920  1705 LDA $20          ;else use space
AB41 2C    1706 .BY $2C          ;skip next instruction
AB42 A91D  1707 BAB42 LDA $1D      ;load Cursor Right
AB44 2C    1708 .BY $2C          ;skip next instruction
AB45 A93F  1709 SAB45 LDA $3F      ;load "?"
AB47 200CE1 1710 SAB47 JSR XE10C    ;output a character
AB4A 29FF  1711 AND $FF          ;and exit with flags corresponding
AB4C 60    1712 RTS             ;to original A

```

```

1714 ;read errors
1715 ;
AB4D A511 1716 JAB4D LDA Z11
AB4F F011 1717 BEQ BAB62 ;skip if INPUT
AB51 3004 1718 BMI BAB57 ;if GET
AB53 A0FF 1719 LDY $FF ;set statement # invalid
AB55 D004 1720 BNE BAB5B
AB57 A53F 1721 BAB57 LDA Z3F
AB59 A440 1722 LDY Z40
AB5B 8539 1723 BAB5B STA Z39
AB5D 843A 1724 STY Z3A
AB5F 4C08AF 1725 BAB5F JMP JAF08
AB62 A513 1726 BAB62 LDA Z13
AB64 F005 1727 BEQ BAB6B
AB66 A218 1728 LDX $18
AB68 4C37A4 1729 JMP JA437
1730 ;
AB6B A90C 1731 BAB6B LDA <TADOC
AB6D AOAD 1732 LDY >TADOC
AB6F 201EAB 1733 JSR SABLE
AB72 A53D 1734 LDA Z3D
AB74 A43E 1735 LDY Z3E
AB76 857A 1736 STA Z7A
AB78 847B 1737 STY Z7B
AB7A 60 1738 RTS
1739 ;
1740 ;"GET" command
1741 ;
AB7B 20A6B3 1742 WAB7B JSR SB3A6 ;check for direct mode
AB7E C923 1743 CMP '#';if next character is # sign
AB80 D010 1744 BNE BAB92
AB82 207300 1745 JSR X0073 ;then get next character
AB85 209EB7 1746 JSR SB79E ;and next integer value in X
AB88 A92C 1747 LDA ','
AB8A 20FFAE 1748 JSR SAEFF ;next character must be a comma
AB8D 8613 1749 STX Z13 ;set new CMD input file
AB8F 201EE1 1750 JSR XE11E ;open device for input
AB92 A201 1751 BAB92 LDX $01 ;set pointer to end of line
AB94 A002 1752 LDY $02
AB96 A900 1753 LDA $00
AB98 8D0102 1754 STA X0200+1 ;set character string terminator
AB9B A940 1755 LDA $40 ;set code for GET
AB9D 200FAC 1756 JSR SACOF ;interpret data
ABA0 A613 1757 LDX Z13 ;get CMD output file
ABA2 D013 1758 BNE BABB7 ;if not default go reset it
ABA4 60 1759 RTS
1760 ;
1761 ;"INPUT#" command
1762 ;
ABA5 209EB7 1763 WABA5 JSR SB79E ;get next integer value in X
ABA8 A92C 1764 LDA ','
ABA9 20FFAE 1765 JSR SAEFF ;next character must be a comma
ABAD 8613 1766 STX Z13 ;set CMD file #
ABA9 201EE1 1767 JSR XE11E ;open device for input
ABB2 20CEAB 1768 JSR SABCE ;do Input
ABB5 A513 1769 JABBS LDA Z13 ;get CMD file number
ABB7 20CCFF 1770 BABB7 JSR XFFCC ;deselect all devices
ABBA A200 1771 LDX $00
ABBC 8613 1772 STX Z13 ;set CMD file to default
ABBE 60 1773 RTS

```

```

1775 ;"INPUT" command
1776 ;
ABBF C922 1777 WABBF CMP `"
ABC1 D00B 1778 BNE SABCE
ABC3 20BDAE 1779 JSR SAEBD
ABC6 A93B 1780 LDA `;
ABC8 20FFAE 1781 JSR SAEFF
ABCB 2021AB 1782 JSR SAB21
ABCE 20A6B3 1783 SABCE JSR SB3A6
ABD1 A92C 1784 LDA `,
ABD3 8DFF01 1785 STA X01FF
ABD6 20F9AB 1786 BABD6 JSR SABF9
ABD9 A513 1787 LDA Z13
ABDB F00D 1788 BEQ BABEA
ABDD 20B7FF 1789 JSR XFFB7
ABE0 2902 1790 AND $02
ABE2 F006 1791 BEQ BABEA
ABE4 20B5AB 1792 JSR JABB5
ABE7 4CF8A8 1793 JMP JA8F8
1794 ;
ABEA AD0002 1795 BABEA LDA X0200
ABED D01E 1796 BNE BACOD
ABEF A513 1797 LDA Z13
ABF1 D0E3 1798 BNE BABD6
ABF3 2006A9 1799 JSR SA906
ABF6 4CFBA8 1800 JMP BA8FB
1801 ;
1802 ;get line into input buffer
1803 ;
ABF9 A513 1804 SABF9 LDA Z13 ;if CMD file = default
ABFB D006 1805 BNE BAC03
ABFD 2045AB 1806 JSR SAB45
AC00 203BAB 1807 JSR SB3B
AC03 4C60A5 1808 BAC03 JMP SA560
1809 ;
1810 ;"READ" command
1811 ;
AC06 A641 1812 WAC06 LDX Z41 ;get current DATA address into XY
AC08 A442 1813 LDY Z42
AC0A A998 1814 LDA $98
AC0C 2C 1815 .BY $2C ;set READ code
AC0D A900 1816 BACOD LDA $00 ;skip next instruction
AC0F 8511 1817 SACOF STA Z11 ;for INPUT, set A to 0
AC11 8643 1818 STX Z43 ;save entry mode
AC13 8444 1819 STY Z44 ;save XY into temporary read pointer
AC15 208BB0 1820 JAC15 JSR SB08B ;gather name & get pointer to variable
AC18 8549 1821 STA Z49 ;store pointer
AC1A 844A 1822 STY Z4A
AC1C A57A 1823 LDA Z7A ;get current character pointer
AC1E A47B 1824 LDY Z7B
AC20 854B 1825 STA Z4B ;save it
AC22 844C 1826 STY Z4C ;get temporary read pointer
AC24 A643 1827 LDX Z43
AC26 A444 1828 LDY Z44
AC28 867A 1829 STX Z7A ;use it as current character pointer
AC2A 847B 1830 STY Z7B
AC2C 207900 1831 JSR X0079 ;get current character
AC2F D020 1832 BNE BAC51 ;if end of statement, get next character
AC31 2411 1833 BIT Z11 ;if GET mode
AC33 500C 1834 BVC BAC41

```

AC35 2024E1	1835	JSR XE124	;get a character from CMD file
AC38 8D0002	1836	STA X0200	;save character in input buffer
AC3B A2F	1837	LDX \$FF	
AC3D A001	1838	LDY \$01	;move buffer address - 1 into XY
AC3F D00C	1839	BNE BAC4D	
AC41 3075	1840	RAC41 BMI BACBC	;if READ go get next DATA element
AC43 A513	1841	LDA Z13	;for INPUT if CMD file = default
AC45 D003	1842	BNE BAC4A	
AC47 2045AB	1843	JSR SAR45	;print "?" on CMD file
AC4A 20F9AB	1844	BAC4A JSR SABF9	;get new input line
AC4D 867A	1845	BAC4D STX Z7A	;store pointer into current pointer
AC4F 847B	1846	STY Z7B	
AC51 207300	1847	BAC51 JSR X0073	;get next pointer
AC54 240D	1848	BIT Z0D	;if not a string variable
AC56 1031	1849	BPL BAC89	
AC58 2411	1850	BIT Z11	;and GET mode
AC5A 5009	1851	BVC BAC65	
AC5C E8	1852	INX	
AC5D 867A	1853	STX Z7A	;skip character
AC5F A900	1854	LDA \$00	;set null as terminator
AC61 8507	1855	STA Z07	
AC63 F00C	1856	BEQ BAC71	
AC65 8507	1857	BAC65 STA Z07	;if string variable and RLAD or INPUT
AC67 C922	1858	CMP "	;store character as terminator
AC69 F007	1859	BEQ BAC72	;if not quote character
AC6B A93A	1860	LDA ":"	;store ":" as terminator
AC6D 8507	1861	STA Z07	
AC6F A92C	1862	LDA ','	
AC71 18	1863	BAC71 CLC	
AC72 8508	1864	BAC72 STA Z08	;and "," as an alternative terminator
AC74 A57A	1865	LDA Z7A	
AC76 A47B	1866	LDY Z7B	
AC78 6900	1867	ADC \$00	
AC7A 9001	1868	BCC BAC7D	
AC7C C8	1869	INY	
AC7D 206DB4	1870	BAC7D JSR SB48D	;get descriptor of string into flp accu
AC80 20E2B1	1871	JSR SB7E2	;move text pointer into current pointer
AC83 20DA9A	1872	JSR SA91DA	
AC86 4C91AC	1873	JMP JAC91	
	1874 ;		
AC89 20F3BC	1875	BAC89 JSR SBCF3	
AC8C A50E	1876	LDA ZOE	;convert string into flp accu
AC8E 20C2A9	1877	JSR SA9C2	;load integer flag
AC91 207900	1878	JAC91 JSR X0079	;assign to integer or real
AC94 F007	1879	BEQ BAC9D	;get current character
AC96 C92C	1880	CMP ',	;must be end of statement
AC98 F003	1881	BEQ BAC9D	;or a comma
AC9A 4C4DAB	1882	JMP JAB4D	;else read error
	1883 ;		
AC9D A57A	1884	BAC9D LDA Z7A	;move current character pointer
AC9F A47B	1885	LDY Z7B	
ACA1 8543	1886	STA Z43	;into temporary read pointer
ACA3 8444	1887	STY Z44	
ACA5 A54B	1888	LDA Z4B	;move saved current character pointer
ACA7 A44C	1889	LDY Z4C	
ACA9 857A	1890	STA Z7A	;to current character pointer
ACAB 847B	1891	STY Z7B	
ACAD 207900	1892	JSR X0079	;get current character
ACB0 F02D	1893	BEQ BACDF	;must be end of statement
ACB2 20FDAL	1894	JSR SAEFD	;or a comma

ACB5 4C15AC	1895	JMP JAC15	;if so repeat read
	1896 ;		
ACB8 2006A9	1897	JSR SA906	;if end of line during READ, get index
ACBB C8	1898	INY	;to end of statement and bump it
ACBC AA	1899	TAX	;move last character
ACBD D012	1900	BNE BACD1	;if zero,
ACBF A20D	1901	LDX \$0D	;point to OUT OF DATA message
ACC1 C8	1902	INY	
ACC2 B17A	1903	LDA (Z7A),Y	;if high of ptr to next statement zero
ACC4 F06C	1904	BEQ BAD32	;fatal error
ACC6 C8	1905	INY	
ACC7 B17A	1906	LDA (Z7A),Y	;move low byte of next statement #
ACC9 853F	1907	STA Z3F	;into DATA statement #
ACCB C8	1908	INY	
ACCC B17A	1909	LDA (Z7A),Y	;high byte also
ACCE C8	1910	INY	
ACCF 8540	1911	STA Z40	
ACD1 20FBA8	1912	BACD1 JSR BA8FB	;add offset to current character pointer
ACD4 207900	1913	JSR X0079	;get current character
ACD7 AA	1914	TAX	
ACD8 E083	1915	CPX \$83	;if not code for DATA
ACDA D0DC	1916	BNE BACB8	;go skip statement
ACDC 4C51AC	1917	JMP BAC51	;set READ pointer
	1918 ;		
ACDF A543	1919	BACDF LDA Z43	;at end of READ statement
ACE1 A444	1920	LDY Z44	;get temporary read pointer
ACE3 A611	1921	LDX Z11	;if GET or READ mode
ACE5 1003	1922	BPL >ACEA	
ACE7 4C27A8	1923	JMP BA827	;go set READ pointer
	1924 ;		
ACEA A000	1925	BACEA LDY \$00	;if INPUT
ACEC B143	1926	LDA (Z43),Y	;must be end of line
ACEE FOOB	1927	BEQ BACFB	
ACFO A513	1928	LDA Z13	;else, if CMD file = default
ACF2 D007	1929	BNE BACFB	
ACF4 A9FC	1930	LDA <TACFC	;set AY to message EXRTA IGNORED
ACF6 AOAC	1931	LDY >TACFC	
ACF8 4C1EAB	1932	JMP SAB1E	;print message
	1933 ;		
ACFB 60	1934	BACFB RTS	
	1935 ;		
	1936 ;messages used during READ		
	1937 ;		
ACFC 3F4558	1938	TACFC .BY \$3F,`E,`X,`T,`R,`A,` ,`I,`G,`N,`O,`R,`E,`D,\$0D,\$00	
ADOC 3F5245	1939	TADOC .BY \$3F,`R,`E,`D,`O,` ,`F,`R,`O,`M,` ,`S,`T,`A,`R,`T	
ADLC D000	1940	.BY \$0D,\$00	

```

1942 ;"NEXT" command
1943 ;
AD1E D004 1944 WAD1E BNE SAD24 ;if no parameters
AL20 A000 1945 LDY $00 ;set index pointer to variable
AD22 F003 1946 BEQ BAD27
AD24 208BBO 1947 SAD24 JSR SB08B ;else gather name & get ptr to variable
AD27 8549 1948 BAD27 STA Z49 ;save pointer
AD29 844A 1949 STY Z4A
AD2B 208AA3 1950 JSR SA38A ;get corresponding FOR block
AD2E F005 1951 BEQ BAD35
AD30 A2UA 1952 LDX $0A ;if not found,
AD32 4C37A4 1953 BAD32 JMP JA437 ;error NEXT WITHOUT FOR
1954 ;
AD35 9A 1955 BAD35 TXS ;if found remove everything on top
AD36 8A 1956 TXA
AD37 18 1957 CLC
AD38 6904 1958 ADC $04
AD3A 48 1959 PHA ;get stack index of STEP value (+ 3)
AD3B 6906 1960 ADC $06
AD3D 8524 1961 STA Z24
AD3F 68 1962 PLA ;save stack index of T0 value (+ 9)
AD40 A001 1963 LDY $01 ;high order byte of stack pointer
AD42 202AEB 1964 JSR SBBA2 ;restore flp accu
AD45 BA 1965 TSX ;get top index
AL46 BD0901 1966 LDA X0100+9,X ;get sign of STEP value (+ 8)
AD49 8566 1967 STA Z66 ;restore sign byte of flp accu
AD4B A549 1968 LDA Z49
AD4D A44A 1969 LDY Z4A ;AY points to FOR variable
AD4F 2067B8 1970 JSR SB867 ;add flp accu to # at AY
AD52 20D0BB 1971 JSR JBBDO ;store flp accu into FOR variable
AD55 A001 1972 LDY $01
AD57 205DBC 1973 JSR SBC5D ;compare flp accu to upper limit
AD5A BA 1974 TSX ;get top index
AD5B 38 1975 SEC
AD5C FD0901 1976 SBC X0100+9 X ;if different from sign of STEP
AD5F F017 1977 BEQ BAD78
AD61 BD0F01 1978 LDA X0100+15 X
AD64 8539 1979 STA Z39 ;restore statement # to start of loop
AD66 BE1001 1980 LDA X0100+16,X
AD69 853A 1981 STA Z3A
AD6B BD1201 1982 LDA X0100+18,X
AL6E 857A 1983 STA Z7A ;restore character ptr to start of loop
AD70 BD1101 1984 LDA X0100+17,X
AD73 857B 1985 STA Z7B
AD75 4CAEA7 1986 BAD75 JMP JA7AE ;go execute next statement
1987 ;
AD78 8A 1988 BAD78 TXA
AD79 6911 1989 ADC $11 ;add 17 to stack pointer
AD7B AA 1990 TAX ;to remove FOR block
AD7C 9A 1991 TXS
AD7D 207900 1992 JSR X0079 ;get current character
AL80 C92C 1993 CMP ',' ;if a comma then execute next statement
AD82 DOF1 1994 BNE BAD75
AD84 207300 1995 JSR X0073 ;else get next character
AD87 2024AD 1996 JSR SAD24 ;and go repeat NEXT statement

```

```

1998 ;get next non-string value
1999 ;
AD8A 209EAD 2000 SAD8A JSR SAD9E      ;get next value
2001 ;
AD8D 18     2002 SAD8D CLC           ;set string not wanted
AD8E 24     2003 .BY $24          ;skip next instruction
2004 ;
2005 ;check value to be string
2006 ;
AD8F 38     2007 SAD8F SEC        ;set string wanted
2008 ;
2009 ;check value accoring to C flag
2010 ;
AD90 240D    2011 SAD90 BIT ZOD      ;test string flag
AD92 3003    2012 BMI BAD97       ;if not string
AD94 B003    2013 BCS BAD99       ;and string wanted, error
AD96 60      2014 BAD96 RTS        ;else return
2015 ;
AD97 BOFD    2016 BAD97 BCS BAD96   ;if string and string wanted, return
AD99 A216    2017 BAD99 LDX $16      ;if string and string not wanted, index
AD9B 4C37A4   2018 JMP JA437       ;TYPE MISMATCH and print error
2019 ;
2020 ;evaluate expression
2021 ;
AD9E A67A    2022 SAD9E LDX Z7A      ;decrement character pointer
ADAO D002    2023 BNE BADA4
ADA2 C67B    2024 DEC Z7B
ADA4 C67A    2025 BADA4 DEC Z7A
ADA6 A200    2026 LDX $00          ;initial priority
ADA8 24      2027 .BY $24          ;skip next instruction
ADA9 48      2028 JADA9 PHA        ;save <=> code
ADAA 8A      2029 TXA
ADAB 48      2030 PHA            ;save priority
ADAC A901    2031 LDA $01          ;one slot on stack wanted
ADAE 20FB43  2032 JSR SA3FB       ;else error OUT OF MEMORY Error
ADB1 2083AE  2033 JSR SAE83      ;get value of next operand in flp accu
ADB4 A900    2034 LDA $00
ADB6 854D    2035 STA Z4D         ;initial <=> code for next diadic
ADB8 207900  2036 JADBB JSR X0079  ;get current character
ADB8 38      2037 JADBB SEC
ADBC E9B1    2038 SBC $B1          ;subtract code for >
ADBE 9017    2039 BCC BADD7      ;branch if lower than \
ADCO C903    2040 CMP $03          ;or if higher than \
ADC2 B013    2041 BCS BADD7      ;if bit added for the second time
ADC4 C901    2042 CMP $01
ADC6 2A      2043 ROL A           ;compute bits for <=>
ADC7 4901    2044 EOR $01          ;bit 2 for <, 1 for = and 0 for \
ADC9 454D    2045 EOR Z4D         ;add to existing <=> code
ADC8 C54D    2046 CMP Z4D
ADCD 9061    2047 BCC BAE30      ;then SYNTAX Error
ADCF 854D    2048 STA Z4D
ADD1 207300  2049 JSR X0073      ;get next character
ADD4 4CBBAD  2050 JMP JADBB      ;and repeat
2051 ;
ADD7 A64D    2052 BADD7 LDX Z4D      ;if no <=> code
ADD9 D02C    2053 BNE BAE07       ;then end at non-diadic character
ADD8 B07B    2054 BCS BAE58       ;diadic index 0-6
ADD9 6907    2055 ADC $07
ADD8 9077    2056 BCC BAE58
ADE1 650D    2057 ADC Z0D        ;add string flag + carry

```

```

ADE3 D003 2058      BNE BADE8      ;if still zero
ADE5 4C3DB6 2059      JMP JB63D      ;apply diadic operator "+" on strings
2060 ;
ADE8 69FF 2061      BADE8 ADC $FF    ;make index 0-6 again
ADEA 8522 2062      STA Z22
ADEC 0A 2063      ASL A
ADED 6522 2064      ADC Z22    ;* 3
ADEF A8 2065      TAY
ADFO 68 2066      BADFO PLA      ;restore priority of stacked diadic
ADF1 D980AO 2067      CMP TA080,Y  ;compare to priority of current diadic
ADP4 B067 2068      BCS BAE5D      ;if stacked higher, apply operator
ADF6 208DAD 2069      JSR SAD8D      ;TYPE MISMATCH if string operand
ADF9 48 2070      BADF9 PHA      ;save priority again
ADFA 2020AE 2071      JADFA JSR SAE20  ;recursive call to evaluate expression
ADFD 68 2072      PLA      ;restore priority again
ADFE A44B 2073      LDY Z4B      ;restore index of current diadic
AE00 1017 2074      BPL BAE19      ;if at end
AE02 AA 2075      TAX      ;and priority = 0
AE03 F056 2076      BEQ BAE5B      ;stop
AE05 D05F 2077      BNE BAE66      ;else apply
AE07 460D 2078      BAE07 LSR ZOD  ;get string flag
AE09 8A 2079      TXA
AE0A 2A 2080      ROL A      ;add to <=> code
AE0B A67A 2081      LDX Z7A
AE0D D002 2082      BNE BAE11      ;decrement character pointer
AE0F C67B 2083      DEC Z7B
AE11 C67A 2084      BAE11 DEC Z7A
AE13 A01B 2085      LDY $1B      ;get index (3*9)
AE15 854D 2086      STA Z4D      ;save <=> code
AE17 D0D7 2087      BNE BADF0      ;and go check priorities
AE19 D980AO 2088      BAE19 CMP TA080,Y  ;if true diadic, compare priorities
AE1C B048 2089      BCS BAE66      ;if stacked priority higher, apply it
AE1E 90D9 2090      BCC BADF9      ;else repeat
2091 ;
2092 ;recursive entry for evaluation of expressions
2093 ;
AE20 B982AO 2094      SAE20 LDA TA080+2,Y ;save pointer to routine for diadic
AE23 48 2095      PHA
AE24 B981AO 2096      LDA TA080+1,Y
AE27 48 2097      PHA
AE28 2033AE 2098      JSR SAE33      ;save rounded value of left operand
AE2B A54D 2099      LDA Z4D      ;get <=> code
AE2D 4CA9AD 2100      JMP JADA9      ;and restart evaluation
2101 ;
AE30 4C08AF 2102      BAE30 JMP JAFO8  ;print SYNTAX Error
2103 ;
2104 ;save rounded value of left operand
2105 ;
AE33 A566 2106      SAE33 LDA Z66      ;get sign of flp accu
AE35 BE80AO 2107      LDX TA080,Y  ;get priority of diadic
AE38 A8 2108      SAE38 TAY
AE39 68 2109      PLA
AE3A 8522 2110      STA Z22      ;save return address in Z22/Z23
AE3C E622 2111      INC Z22
AE3E 68 2112      PLA
AE3F 8523 2113      STA Z23
AE41 98 2114      TYA
AE42 48 2115      PHA      ;save sign of flp accu
AE43 201BBC 2116      JAE43 JSR SBC1B  ;round flp accu
AE46 A565 2117      LDA Z65      ;save flp accu on stack

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AE48 48	2118	PHA	
AE49 A564	2119	LDA Z64	
AE4B 48	2120	PHA	
AE4C A563	2121	LDA Z63	
AE4E 48	2122	PHA	
AE4F A562	2123	LDA Z62	
AE51 48	2124	PHA	
AE52 A561	2125	LDA Z61	
AE54 48	2126	PHA	
AE55 6C2200	2127	JMP ,(222) ~ ;return to caller	
	2128 ;		
	2129 ;apply diadic operator		
	2130 ;		
AE58 AOFF	2131 BAE58 LDY \$FF	;at expression end, set negative index	
AE5A 68	2132 PLA	;restore diadic priority from stack	
AE5B F023	2133 BAE5B BEQ BAE80	;if zero, stop	
AE5D C964	2134 BAE5D CMP \$64	;if not priority of <=>	
AE5F F003	2135 BEQ BAE64		
AE61 208DAD	2136 JSR SAD8D	;then TYPE MISMATCH if string	
AE64 844B	2137 BAE64 STY Z4B	;save index of current diadic	
AE66 68	2138 BAE66 PLA	;remove string flag	
AE67 4A	2139 LSR A		
AE68 8512	2140 STA Z12	;save <=> code for <=> routine	
AE6A 68	2141 PLA	;restore left operand	
AE6B 8569	2142 STA Z69	;to second f1p accu	
AE6D 68	2143 PLA		
AE6E 856A	2144 STA Z6A		
AE70 68	2145 PLA		
AE71 856B	2146 STA Z6B		
AE73 68	2147 PLA		
AE74 856C	2148 STA Z6C		
AE76 68	2149 PLA		
AE77 856D	2150 STA Z6D		
AE79 68	2151 PLA		
AE7A 856E	2152 STA Z6E		
AE7C 4566	2153 EOR Z66	;Exclusive OR of both signs	
AE7E 856F	2154 STA Z6F		
AE80 A561	2155 BAE80 LDA Z61	;return with A = exponent of result	
AE82 60	2156 RTS		

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AE83 6C0A03 2158 SAE83 JMP (X030A) ;get arithmetic element (normally AE86)
2159 ;
2160 ;get arithmetic element into flp accu
2161 ;
AE86 A900 2162 LDA $00 ;set string flag to not string
AE88 850D 2163 STA Z0D
AE8A 207300 2164 BAE8A JSR X0073 ;get next character
AE8D B003 2165 BCS BAE92 ;if numeric,
AE8F 4CF3BC 2166 BAE8F JMP SBCF3 ;gather number
2167 ;
AE92 2013B1 2168 BAE92 JSR SB113 ;check for alphabetic character
AE95 9003 2169 BCC BAE9A
AE97 4C28AF 2170 JMP JAF28 ;if so, get value for variable
2171 ;
AE9A C9FF 2172 BAE9A CMP $FF ;if code for PI
AE9C D00F 2173 BNE BAEAD
AE9E A9A8 2174 LDA <TAEA8 ;let AY point to value for PI
AEA0 AOAE 2175 LDY >TAEA8
AEA2 20A2BB 2176 JSR SBBA2 ;load value into flp accu
AEA5 4C7300 2177 JMP X0073 ;get next character
2178 ;
2179 ;flp value for PI
2180 ;
AEA8 82490F 2181 TAEA8 .BY $82,$49,$0F,$DA,$A1
2182 ;
AEAD C92E 2183 BAEAD CMP ` . ;if decimal point
AEAF FODE 2184 BEQ BAE8F ;gather number
AEB1 C9AB 2185 CMP $AB ;if minus sign
AEB3 F058 2186 BEQ BAFOF ;do recursive get value
AEB5 C9AA 2187 CMP $AA ;if plus
AEB7 F0D1 2188 BEQ BAE8A ;ignore
AEB9 C922 2189 CMP ` " ;if quote
AEBB DOOF 2190 BNE BAECC
AEBD A57A 2191 SAEBD LDA Z7A ;get pointer to first char of string
AEBF A47B 2192 LDY Z7B
AEC1 6900 2193 ADC $00 ;into Y
AEC3 9001 2194 BCC BAEC6
AEC5 C8 2195 INY
AEC6 2087B4 2196 BAECC JSR SB487 ;get ptr to desc of constant string
AEC9 4CE2B7 2197 JMP SB7E2 ;set current ptr after string
2198 ;
AECC C9A8 2199 BAECC CMP $A8 ;if NOT
AECE D013 2200 BNE BAEE3
AED0 A018 2201 LDY $18 ;set index for NOT
AED2 D03B 2202 BNE BAFOF ;do recursive get value

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```

2204 ;monadic "NOT" command
2205 ;
AED4 20BFB1 2206 WAED4 JSR SB1BF      ;convert flp to integer
AED7 A565 2207 LDA Z65
AED9 49FF 2208 EOR $FF      ;get complement of low byte into A
AEDB A8 2209 TAY
AEDC A564 2210 LDA Z64      ;get complement of high byte in A
AEDE 49FF 2211 EOR $FF
AEE0 4C91B3 2212 JMP JB391      ;convert integer to flp
2213 ;
2214 ;continuation of GET operand
2215 ;
AEE3 C9A5 2216 BAEE3 CMP $A5      ;if FN
AEE5 D003 2217 BNE BAEFA
AEE7 4CF4B3 2218 JMP JB3F4      ;expand function
2219 ;
AEEE C9B4 2220 BAEFA CMP $B4      ;if code for SGN or higher
AEEC 9003 2221 BCC BAEF1
AEEE 4CA7AF 2222 JMP JAFA7      ;go apply function
2223 ;
AEF1 20FAAE 2224 BAEF1 JSR SAEFA      ;SYNTAX Error if no "(" present
AEF4 209EAD 2225 JSR SAD9E      ;evaluate expression
2226 ;
2227 ;check and skip characters
2228 ;
AEF7 A929 2229 SAEF7 LDA ')      ;check for ")"
AEF9 2C 2230 .BY $2C      ;skip next instruction
AEFA A928 2231 SAEFA LDA '('      ;check for "("
AEFC 2C 2232 .BY $2C      ;skip next instruction
AEFD A92C 2233 SAEFD LDA ','      ;check for ","
AEFF A000 2234 SAEFF LDY $00      ;check for code in A
AF01 D17A 2235 CMP (Z7A),Y      ;if current character < > to parameter
AF03 D003 2236 BNE JAF08      ;then SYNTAX Error
AF05 4C7300 2237 JMP X0073      ;else get next character and return
2238 ;
AF08 A20B 2239 JAF08 LDX $0B      ;point to SYNTAX Error message
AF0A 4C37A4 2240 JMP JA437      ;print message
2241 ;
2242 ;recursive get value
2243 ;
AF0D A015 2244 BAF0D LDY $15      ;set index for "-"
AF0F 68 2245 BAF0F PLA      ;remove own return address
AF10 68 2246 PLA
AF11 4CFAAD 2247 JMP JADFA      ;do pseudo diadic
2248 ;
2249 ;check variable pointer range
2250 ;
AF14 38 2251 SAF14 SEC
AF15 A564 2252 LDA Z64
AF17 E900 2253 SBC $00
AF19 A565 2254 LDA Z65
AF1B E9A0 2255 SBC $AO
AF1D 9008 2256 BCC BAF27      ;exit with C clear if pointer < $A000
AF1F A9A2 2257 LDA $A2
AF21 E564 2258 SBC Z64
AF23 A9E3 2259 LDA $E3
AF25 E565 2260 SBC Z65      ;clear C if $E342 < pointer
AF27 60 2261 BAF27 RTS

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```

2263 ;get value of variable
2264 ;
AF28 208BBO 2265 JAF28 JSR SB08B ;gather name and get pointer to variable
AF2B 8564 2266 STA Z64 ;save pointer to variable
AF2D 8465 2267 STY Z65
AF2F A645 2268 LDX Z45 ;get name of variable
AF31 A446 2269 LDY Z46
AF33 A50D 2270 LDA Z0D ;if not a string
AF35 F026 2271 BEQ BAF5D ;go check for integer and flp
AF37 A900 2272 LDA $00
AF39 8570 2273 STA Z70
AF3B 2014AF 2274 JSR SAF14 ;check for pointer < $A000 or > $E342
AF3E 901C 2275 BCC BAF5C ;yes, return
AF40 E054 2276 CPX 'T ;if first character of variable not T,
AF42 D018 2277 BNE BAF5C ;return
AF44 COC9 2278 CPY $C9 ;if second character = "I$"
AF46 D014 2279 BNE BAF5C
AF48 2084AF 2280 JSR SAF84 ;get time in flp accu
AF4B 845E 2281 STY Z5E ;clear exponent base 10
AF4D 88 2282 DEY
AF4E 8471 2283 STY Z71 ;initialize output index
AF50 A006 2284 LDY $06 ;and # of digits before decimal point
AF52 845D 2285 STY Z5D
AF54 A024 2286 LDY $24 ;set table index for time conversion
AF56 2068BE 2287 JSR SBE68 ;convert flp to string
AF59 4C6FB4 2288 JMP JB46F ;get description of string into flp accu
2289 ;
AF5C 60 2290 BAF5C RTS
2291 ;
AF5D 240E 2292 BAF5D BIT Z0E ;if integer variable
AF5F 100D 2293 BPL BAF6E
AF61 A000 2294 LDY $00
AF63 B164 2295 LDA (Z64),Y ;get integer value in AY
AF65 AA 2296 TAX
AF66 C8 2297 INY
AF67 B164 2298 LDA (Z64),Y
AF69 A8 2299 TAY
AF6A 8A 2300 TXA
AF6B 4C91B3 2301 JMP JB391 ;convert integer to flp
2302 ;
AF6E 2014AF 2303 BAF6E JSR SAF14 ;if not normal variable
AF71 902D 2304 BCC BAF6E
AF73 E054 2305 CPX 'T ;and if first character is T
AF75 D01B 2306 BNE BAF92
AF77 C049 2307 CPY 'I ;and second character is I
AF79 D025 2308 BNE BAF60
AF7B 2084AF 2309 JSR SAF84 ;get time into flp accu
AF7E 98 2310 TYA
AF7F A2A0 2311 LDX $A0 ;set exponent
AF81 4C4FBC 2312 JMP JBC4F ;sign and guard bits

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```

2314 ;get time in flp accu
2315 ;
AF84 20DEFF 2316 SAF84 JSR XFFDE      ;fetch time
AF87 8664   2317   STX Z64
AF89 8463   2318   STY Z63      ;store time
AF8B 8565   2319   STA Z65
AF8D A000   2320   LDY $00
AF8F 8462   2321   STY Z62
AF91 60     2322   RTS
2323 ;
2324 ;continue to get value of variable
2325 ;
AF92 E053   2326 BAF92 CPX 'S      ;if first character is S
AF94 D00A   2327   BNE BAFA0
AF96 C054   2328   CPY 'T      ;and second character is T
AF98 D006   2329   BNE BAFA0
AF9A 20B7FF  2330   JSR XFFB7    ;get status word
AF9D 4C3CBC  2331   JMP JBC3C    ;move signed # from A into flp accu
2332 ;
AFA0 A564   2333 BAFA0 LDA Z64    ;for normal variables, put pointer in AY
AFA2 A465   2334   LDY Z65
AFA4 4CA2BB  2335   JMP SBBA2    ;load flp accu from AY
2336 ;
2337 ;apply function
2338 ;
AFA7 0A     2339 JAFA7 ASL A      ;index byte * 2
AFA8 48     2340   PHA          ;save index
AFA9 AA     2341   TAX
AFAA 207300 2342   JSR X0073    ;get next character
AFAD E08F   2343   CPX $8F      ;if function with more than 1 parameter
AFAF 9020   2344   BCC BAFD1
AFB1 20FAAE 2345   JSR SAEFA    ;next character must be "("
AFB4 209EAD 2346   JSR SAD9E    ;evaluate expression
AFB7 20FDAE 2347   JSR SAEFD    ;next character must be ","
AFBA 208FAD 2348   JSR SAD8F    ;result must be a string value
AFBD 68     2349   PLA          ;restore index
AFBE AA     2350   TAX
AFBF A565   2351   LDA Z65      ;save pointer to description on stack
AFC1 48     2352   PHA
AFC2 A564   2353   LDA Z64
AFC4 48     2354   PHA
AFC5 8A     2355   TXA          ;save index again
AFC6 48     2356   PHA
AFC7 209EB7 2357   JSR SB79E    ;get next integer value into X
AFC8 68     2358   PLA          ;restore index
AFCB A8     2359   TAY          ;index in Y
AFCC 8A     2360   TXA
AFCD 48     2361   PHA          ;save integer parameter
AFCE 4CD6AF 2362   JMP JAFD6
2363 ;
AFD1 20F1AE 2364 BAFD1 JSR BAEF1    ;get value in parenthesis
AFD4 68     2365   PLA          ;restore index
AFD5 A8     2366   TAY
AFD6 B9EA9F 2367 JAFD6 LDA X9FEA,Y ;get pointer to function routine
AFD9 8555   2368   STA Z55      ;into Z55/Z56
AFDB B9EB9F 2369   LDA X9FEA+1,Y
AFDE 8556   2370   STA Z56
AFE0 205400 2371   JSR X0054    ;perform function
AFE3 4C8DAD 2372   JMP SAD8D    ;return with correct string flag

```

	2374 ; "OR" command	
	2375 ;	
AFE6 A0FF	2376 WAFE6 LDY \$FF	; set parameter to complement operands
AFE8 2C	2377 .BY \$2C	; skip next instruction
	2378 ;	
	2379 ; "AND" command	
	2380 ;	
AFF9 A000	2381 WAFE9 LDY \$00	; set no complement of operands
AFFB 840B	2382 STY ZOB	; store the parameter
AFED 20BFBI	2383 JSR SB1BF	; convert left operand to integer
AFF0 A564	2384 LDA Z64	; get high byte
AFF2 450B	2385 EOR ZOB	; complement if OR
AFF4 8507	2386 STA Z07	; save result
AFF6 A565	2387 LDA Z65	; get low byte
AFF8 450B	2388 EOR ZOB	; complement if OR
AFFA 8508	2389 STA Z08	; save result
AFFC 20FCBB	2390 JSR SBBFC	; move second f1p accu to first f1p accu
AFFF 20BFBI	2391 JSR SB1BF	; convert right operand to integer
B002 A565	2392 LDA Z65	; get low byte
B004 450B	2393 EOR ZOB	; complement if OR
B006 2508	2394 AND Z08	; AND with left operand
B008 450B	2395 EOR ZOB	; complement if OR
B00A A8	2396 TAY	; save result
B00B A564	2397 LDA Z64	; get high byte
B00L 450B	2398 EOR ZOB	; complement if OR
B00F 2507	2399 AND Z07	; AND with other operand
B011 450B	2400 EOR ZOB	; complement if OR
B013 4C91B3	2401 JMP JB391	; convert integer from AY to f1p accu

```

2403 ;"<=>" command
2404 ;
B016 2090AD 2405 WB016 JSR SAD90 ;check value of A
B019 B013 2406 BCS BB02E ;if string, go compare strings
B01B A56E 2407 LDA Z6E ;include sign bit
B01D 097F 2408 ORA $7F
B01F 256A 2409 AND Z6A ;into byte 1
B021 856A 2410 STA Z6A ;of fraction of second flp accu
B023 A969 2411 LDA <Z69
B025 A000 2412 LDY >Z69 ;set AY to second flp accu
B027 205BBC 2413 JSR SBC5B ;compare AY with flp accu
B02A AA 2414 TAX ;save result of comparison
B02B 4C61B0 2415 JMP JB061 ;check with <=> code
2416 ;
B02E A900 2417 BB02E LDA $00 ;reset string flag
B030 850D 2418 STA Z0D ;also remove saved string flag
B032 C64D 2419 DEC Z4D ;de-allocate temp. string (right op)
B034 20A6B6 2420 JSR SB6A6
B037 8561 2421 STA Z61
B039 8662 2422 STX Z62
B03B 8463 2423 STY Z63
B03D A56C 2424 LDA Z6C ;get text pointer of left operand
B03F A46D 2425 LDY Z6D ;de-allocate temp. string (left op)
B041 20AA86 2426 JSR SB6AA ;save text pointer
B044 866C 2427 STX Z6C
B046 846D 2428 STY Z6D
B048 AA 2429 TAX ;save length of left operand
B049 38 2430 SEC
B04A E561 2431 SBC Z61 ;compare lengths (left-right)
B04C F008 2432 BEQ BB056 ;if equal, A=0
B04E A901 2433 LDA $01 ;set A to 1
B050 9004 2434 BCC BB056 ;if left operand longer,
B052 A661 2435 LDX Z61 ;get length of shorter string
B054 A9FF 2436 LDA $FF ;and set A to -1
B056 8566 2437 BB056 STA Z66 ;save sign of left-right
B058 A0FF 2438 LDY $FF ;set start index into strings
B05A E8 2439 INX
B05B C8 2440 BB05B INY ;point to next character
B05C CA 2441 DEX
B05D D007 2442 BNE BB066 ;if more characters, compare
B05F A666 2443 LDX Z66 ;if not, restore sign of left-right
B061 300F 2444 JB061 BMI BB072
B063 18 2445 CLC ;set correct C bit
B064 900C 2446 BCC BB072 ;JMP
B066 B16C 2447 BB066 LDA (Z6C),Y ;get character from left string
B068 D162 2448 CMP (Z62),Y ;compare to character from right string
B06A FOEF 2449 BEQ BB05B ;if equal, repeat
B06C A2FF 2450 LDX $FF ;X = -1 if character from left higher
B06E B002 2451 BCS BB072
B070 A201 2452 LDX $01 ;X = 1 if character from left lower
B072 E8 2453 BB072 INX ;X = 0, 1 or 2 for left > = <
B073 8A 2454 TXA ;convert to 1, 2 or 4
B074 2A 2455 ROL A ;mask with <=> code
B075 2512 2456 AND Z12 ;if zero, result = false (0)
B077 F002 2457 BEQ BB07B ;if non-zero, result = true (-1)
B079 A9FF 2458 LDA $FF ;go get signed # from A into flp accu
B07B 4C3CBC 2459 BB07B JMP JBC3C

```

```

2461 ;"DIM" command
2462 ;
B07E 20FDAE 2463 BB07E JSR SAEFD ;SYNTAX Error if not ","
B081 AA 2464 WB081 TAX
B082 2090BO 2465 JSR SB090 ;gather name and pointer to variable
B085 207900 2466 JSR X0079 ;get current character
B088 DOF4 2467 BNE BB07E ;if not end of statement, repeat
B08A 60 2468 RTS
2469 ;
2470 ;get name and pointer to a variable
2471 ;
B08B A200 2472 SB08B LDX $00 ;set code for ref, not declaration
B08D 207900 2473 JSR X0079 ;get current character
B090 860C 2474 SB090 STX ZOC ;set reference/declaration flag
B092 8545 2475 SB092 STA Z45 ;store first character of name
B094 207900 2476 JSR X0079 ;get current character
B097 2013B1 2477 JSR SB113 ;if not alphabetic
B09A B003 2478 BCS BB09F
B09C 4C08AF 2479 BB09C JMP JAF08 ;then SYNTAX Error message
2480 ;
B09F A200 2481 BB09F LDX $00 ;set flags
B0A1 860D 2482 STX ZOD ;to not string
B0A3 860E 2483 STX ZOE ;and not integer
B0A5 207300 2484 JSR X0073 ;get next character
B0A8 9005 2485 BCC BBOAF ;if numeric
B0AA 2013B1 2486 JSR SB113
B0AD 900B 2487 BCC BBOBA ;or alphabetic
B0AF AA 2488 BBOAF TAX
B0B0 207300 2489 BB0BO JSR X0073 ;get next character
B0B3 90FB 2490 BCC BBOBO ;until first non-numeric character
B0B5 2013B1 2491 JSR SB113
B0B8 BOF6 2492 BCS BBOBO ;not alphabetic
B0BA C924 2493 BB0BA CMP '$' ;if terminator is "$"
B0BC D006 2494 BNE BB0C4
B0BE A9FF 2495 LDA $FF
B0C0 850D 2496 STA ZOD ;then set flag for strings
B0C2 D010 2497 BNE BB0D4
B0C4 C925 2498 BB0C4 CMP '%' ;if terminator is "%"
B0C6 D013 2499 BNE BB0DB ;and integers not allowed
B0C8 A510 2500 LDA Z10 ;then SYNTAX Error
B0CA D0D0 2501 BNE BB09C
B0CC A980 2502 LDA $80
B0CE 850E 2503 STA ZOE ;else set integer flag and
B0D0 0545 2504 ORA Z45 ;add bit 7 to first char of name
B0D2 8545 2505 STA Z45
B0D4 8A 2506 BB0D4 TXA ;add bit 7 to 2nd char of name
B0D5 0980 2507 ORA $80 ;for both string and integer
B0D7 AA 2508 TAX
B0D8 207300 2509 JSR X0073 ;get next character
B0D8 8646 2510 BB0DB STX Z46 ;save second character name
B0DD 38 2511 SEC
B0DE 0510 2512 ORA Z10 ;if arrays allowed
B0EO E928 2513 SBC '(' ;and next character is "("
B0E2 D003 2514 BNE BBOE7
B0E4 4CD1B1 2515 JMP JB1D1 ;handle dimensioned variable
2516 ;
B0E7 A000 2517 BBOE7 LDY $00 ;reset no integers or arrays switch
B0E9 8410 2518 STY Z10
B0EB A52D 2519 LDA Z2D
B0ED A62E 2520 LDX Z2E ;AX=pointer to variable name table

```

```

B0EF 8660 2521 BBOEF STX Z60
B0F1 855F 2522 BBOF1 STA Z5F
B0F3 E430 2523 CPX Z30      ;if at end of name table
B0F5 D004 2524 BNE BBOFB
B0F7 C52F 2525 CMP Z2F
B0F9 F022 2526 BEQ BB11D    ;then variable not found
B0FB A545 2527 BBOFB LDA Z45
B0FD D15F 2528 CMP (Z5F),Y ;if name matches
B0FF D008 2529 BNE BB109
B101 A546 2530 LDA Z46
B103 C8   2531 INY
B104 D15F 2532 CMP (Z5F),Y
B106 F07D 2533 BEQ BB185    ;then variable found
B108 88   2534 DEY
B109 18   2535 BB109 CLC
B10A A55F 2536 LDA Z5F      ;set AX to entry + 7
B10C 6907 2537 ADC $07
B10E 90E1 2538 BCC BBOF1
B110 E8   2539 INX
B111 D0DC 2540 BNE BBOEF    ;continue search
2541 ;
2542 ;check character in A
2543 ;
2544 ;return with C=1 if alphabetic
2545 ;return with C=0 if not
2546 ;
B113 C941 2547 SB113 CMP `A     ;if character < "A"
B115 9005 2548 BCC BB11C    ;return with C = 0
B117 E95B 2549 SBC `Z+1     ;if character > "Z" then C = 0
B119 38   2550 SEC
B11A E9A5 2551 SBC $A5      ;else return with C=1
B11C 60   2552 BB11C RTS
2553 ;
2554 ;variable not found
2555 ;
B11D 68   2556 BB11D PLA    ;if low byte of return address = $2A
B11E 48   2557 PHA          ;(if called from GET VALUE OF VARIABLE)
B11F C92A 2558 CMP $2A
B121 D005 2559 BNE BB128
B123 A913 2560 BB123 LDA $13 ;return with AY pointing to
B125 A0BF 2561 LDY $BF      ;a dummy variable (value 0)
B127 60   2562 RTS
2563 ;
B128 A545 2564 BB128 LDA Z45
B12A A446 2565 LDY Z46
B12C C954 2566 CMP `T      ;if name = TI$
B12E D00B 2567 BNE BB13B
B130 C0C9 2568 CPY $C9
B132 FOEF 2569 BEQ BB123    ;return with dummy value
B134 C049 2570 CPY `I      ;if name=TI
B136 D003 2571 BNE BB13B
B138 4C08AF 2572 BB138 JMP JAF08    ;then SYNTAX Error
2573 ;
B13B C953 2574 BB13B CMP `S    ;if name=ST
B13D D004 2575 BNE BB143
B13F C054 2576 CPY `T
B141 F0F5 2577 BEQ BB138    ;then SYNTAX Error
B143 A52F 2578 BB143 LDA Z2F    ;set AY to pointer to end of name table
B145 A430 2579 LDY Z30
B147 855F 2580 STA Z5F      ;and save as start of input for move

```

B149 8460	2581	STY Z60	
B14B A531	2582	LDA Z31	;AY=pointer to end of array area
B14D A432	2583	LDY Z32	
B14F 855A	2584	STA Z5A	
B151 845B	2585	STY Z5B	
B153 18	2586	CLC	
B154 6907	2587	ADC \$07	;add 7 to pointer for one entry
B156 9001	2588	BCC BB159	
B158 C8	2589	INY	
B159 8558	2590	BB159 STA Z58	;into pointer to end of output for move
B15B 8459	2591	STY Z59	
B15D 20B8A3	2592	JSR SA3B8	;check for space and move bytes
B160 A558	2593	LDA Z58	
B162 A459	2594	LDY Z59	;AY=beginning of output area
B164 C8	2595	INY	
B165 852F	2596	STA Z2F	;for move routine
B167 8430	2597	STY Z30	;move to pointer to end of name table
B169 A000	2598	LDY \$00	
B16B A545	2599	LDA Z45	
B16D 915F	2600	STA (Z5F),Y	;store first byte of name in byte 0
B16F C8	2601	INY	
B170 A546	2602	LDA Z46	
B172 915F	2603	STA (Z5F),Y	;store second byte of name in byte 1
B174 A900	2604	LDA \$00	
B176 C8	2605	INY	
B177 915F	2606	STA (Z5F),Y	;clear bytes 2-6 (value)
B179 C8	2607	INY	
B17A 915F	2608	STA (Z5F),Y	
B17C C8	2609	INY	
B17D 915F	2610	STA (Z5F),Y	
B17F C8	2611	INY	
B180 915F	2612	STA (Z5F),Y	
B182 C8	2613	INY	
B183 915F	2614	STA (Z5F),Y	
	2615 ;		
	2616 ;variable found		
	2617 ;		
B185 A55F	2618	BB185 LDA Z5F	
B187 18	2619	CLC	;return pointer to entry
B188 6902	2620	ADC \$02	;plus 2
B18A A460	2621	LDY Z60	
B18C 9001	2622	BCC BB18F	
B18E C8	2623	INY	
B18F 8547	2624	BB18F STA Z47	;in variable address and AY
B191 8448	2625	STY Z48	
B193 60	2626	RTS	

```

        2628 ;compute pointer to array body
2629 ;
B194 A50B 2630 SB194 LDA Z0B      ;get # of dimensions
B196 0A    2631 ASL A           ;* 2
B197 6905  2632 ADC $05        ;add fixed overhead
B199 655F  2633 ADC Z5F        ;add low byte of array pointer
B19B A460  2634 LDY Z60        ;get high byte of array pointer
B19D 9001  2635 BCC BB1AO
B19F C8    2636 INY            ;increment if carry
B1A0 8558  2637 BB1AO STA Z58  ;save pointer to body of array
B1A2 8459  2638 STY Z59
B1A4 60    2639 RTS
2640 ;
2641 ;flop number for conversion to integer
2642 ;
B1A5 908000 2643 TBLA5 .BY $90,$80,$00,$00,$00
2644 ;
2645 ;routine to convert floating point number to fixed point
2646 ;
B1AA 20BF81 2647 JSR SB1BF      ;convert flop to fixed point
B1AD A564  2648 LDA Z64
B1AF A465  2649 LDY Z65        ;return with value in AY
B1B1 60    2650 RTS
2651 ;
2652 ;convert value from statement into integer
2653 ;
B1B2 207300 2654 SB1B2 JSR X0073  ;get next character
B1B5 209EAD 2655 JSR SAD9E    ;get value from statement
B1B8 208DAD 2656 SB1B8 JSR SAD8D  ;check for non-string
B1BB A566  2657 LDA Z66        ;if flop accu negative,
B1BD 300D  2658 BMI BB1CC     ;ILLEGAL QUANTITY Error
2659 ;
2660 ;convert flop number to integer
2661 ;
B1BF A561  2662 SB1BF LDA Z61  ;get exponent
B1C1 C990  2663 CMP $90       ;if < 16
B1C3 9009  2664 BCC BB1CE    ;convert
B1C5 A9A5  2665 LDA <TB1A5   ;let AY point to flop value -32768
B1C7 A0B1  2666 LDY >TB1A5
B1C9 205BBC 2667 JSR SBC5B    ;compare AY to flop accu
B1CC D07A  2668 BB1CC BNE JB248 ;if not >, ILLEGAL QUANTITY Error
B1CE 4C9BBC 2669 BB1CE JMP SBC9B ;convert flop accu to 4 byte integer

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```

2671 ;get pointer to dimensioned variable
2672 ;
B1D1 A50C 2673 JB1D1 LDA ZOC      ;save reference flag
B1D3 050E 2674 ORA ZOE      ;and integer flag
B1D5 48   2675 PHA
B1D6 A50D 2676 LDA ZOD      ;save string flag
B1D8 48   2677 PHA
B1D9 A000 2678 LDY $00       ;initialize count # of dimensions
B1D8 98   2679 BB1DB TYA
B1DC 48   2680 PHA      ;save count
B1DD A546 2681 LDA Z46
B1DF 48   2682 PHA      ;save second character of name
B1E0 A545 2683 LDA Z45
B1E2 48   2684 PHA      ;save first character of name
B1E3 20B2B1 2685 JSR SB1B2  ;convert value from statement to integer
B1E6 68   2686 PLA
B1E7 8545 2687 STA Z45      ;restore first character of name
B1E9 68   2688 PLA
B1EA 8546 2689 STA Z46      ;restore second character of name
B1EC 68   2690 PLA
B1ED A8   2691 TAY      ;restore count
B1EE BA   2692 TSX      ;get stack pointer
B1EF BDO201 2693 LDA X0102,X
B1F2 48   2694 PHA      ;move saved flags to top of stack
B1F3 BD0101 2695 LDA X0101,X
B1F6 48   2696 PHA
B1F7 A564  2697 LDA Z64      ;save array index in their place
B1F9 9D0201 2698 STA X0102,X
B1FC A565  2699 LDA Z65
B1FE 9D0101 2700 STA X0101,X
B201 C8   2701 INY      ;increment dimension pointer
B202 207900 2702 JSR X0079  ;get current character
B205 C92C  2703 CMP ','
B207 F0D2  2704 BEQ BB1DB  ;repeat for next array index
B209 840B  2705 STY ZOB  ;save total number of dimensions
B20B 20F7AE 2706 JSR SAEF7 ;skip ")"
B20E 68   2707 PLA
B20F 850D  2708 STA ZOD  ;restore string flag
B211 68   2709 PLA
B212 850E  2710 STA ZOE  ;restore integer flag
B214 297F  2711 AND $7F
B216 850C  2712 STA ZOC  ;and reference flag
B218 A62F  2713 LDX Z2F
B21A A530  2714 LDA Z30  ;AX = pointer to array area
B21C 865F  2715 BB21C STX Z5F
B21E 8560  2716 STA Z60  ;save in temporary pointer
B220 C532  2717 CMP Z32
B222 D004  2718 BNE BB228 ;if end of array area reached
B224 E431  2719 CPX Z31
B226 F039  2720 BEQ BB261 ;then array not found
B228 A000  2721 BB228 LDY $00
B22A B15F  2722 LDA (Z5F),Y ;get first character of name
B22C C8   2723 INY
B22D C545  2724 CMP Z45  ;if equal
B22F D006  2725 BNE BB237
B231 A546  2726 LDA Z46
B233 D15F  2727 CMP (Z5F),Y ;and second character of name also
B235 F016  2728 BEQ BB24D ;then array found
B237 C8   2729 BB237 INY
B238 B15F  2730 LDA (Z5F),Y ;get low byte of length

```

B23A 18	2731	CLC	
B23B 655F	2732	ADC Z5F	;add to array pointer
B23D AA	2733	TAX	;and save result in X
B23E C8	2734	INY	
B23F B15F	2735	LDA (Z5F),Y	;get high byte of length
B241 6560	2736	ADC Z60	;add to array pointer
B243 90D7	2737	BCC BB21C	;repeat if not overflow
B245 A212	2738	BB245 LDX \$12	;point to BAD SUBSCRIPT Error message
B247 2C	2739	.BY \$2C	;skip next instruction
	2740 ;		
B248 A20E	2741	JB248 LDX \$0E	;point to ILLEGAL QUANTITY Error message
B24A 4C37A4	2742	BB24A JMP JA437	;print message
B24D A213	2743	BB24D LDX \$13	;point to BAD SUBSCRIPT Error message
B24F A50C	2744	LDA Z0C	;if declaration
B251 D0F7	2745	BNE BB24A	;then fatal error
B253 2094B1	2746	JSR SB194	;compute pointer to array body
B256 A50B	2747	LDA Z0B	;if actual # of dimensions
B258 A004	2748	LDY \$04	
B25A D15F	2749	CMP (Z5F),Y	;not equal to declared #
B25C D0E7	2750	BNE BB245	;then error
B25E 4CEAB2	2751	JMP JB2EA	;else compute array reference

```

2753 ;allocate array
2754 ;
B261 2094B1 2755 BB261 JSR SB194 ;compute pointer to virtual array body
B264 2008A4 2756 JSR SA408 ;check array area for overflow
B267 A000 2757 LDY $00
B269 8472 2758 STY Z72 ;initialize high byte of length
B26B A205 2759 LDX $05 ;set length per element
B26D A545 2760 LDA Z45 ;get first character of name
B26F 915F 2761 STA (Z5F),Y ;into + 0 of array header
B271 1001 2762 BPL BB274 ;if integer
B273 CA 2763 DEX ;adjust length per element
B274 C8 2764 BB274 INY
B275 A546 2765 LDA Z46 ;move second character of name
B277 915F 2766 STA (Z5F),Y ;into + 1 of array header
B279 1002 2767 BPL BB27D ;if integer or string
B27B CA 2768 DEX
B27C CA 2769 DEX ;correct length per element
B27D 8671 2770 BB27D STX Z71 ;set initial low byte of length
B27F A50B 2771 LDA ZOB ;move # of dimensions
B281 C8 2772 INY
B282 C8 2773 INY
B283 C8 2774 INY
B284 915F 2775 STA (Z5F),Y ;into + 4 of array header
B286 A20B 2776 BB286 LDX $0B ;set default dimension (11)
B288 A900 2777 LDA $00
B28A 240C 2778 BIT ZOC ;if declaration
B28C 5008 2779 BVC BB296 ;skip
B28E 68 2780 PLA ;else get limit from stack
B28F 18 2781 CLC
B290 6901 2782 ADC $01 ;add 1 for element # 0
B292 AA 2783 TAX
B293 68 2784 PLA ;limit into AX
B294 6900 2785 ADC $00
B296 C8 2786 BB296 INY
B297 915F 2787 STA (Z5F),Y ;move limit into next byte of header
B299 C8 2788 INY
B29A 8A 2789 TXA
B29B 915F 2790 STA (Z5F),Y ;low byte also
B29D 204CB3 2791 JSR SB34C ;AX = length * limit
B2A0 8671 2792 STX Z71
B2A2 8572 2793 STA Z72 ;save into length
B2A4 A422 2794 LDY Z22 ;restore index into array header
B2A6 C60B 2795 DEC ZOB ;decrement # of dimensions
B2A8 DODC 2796 BNE BB286 ;repeat until done
B2AA 6559 2797 ADC Z59 ;add high byte of length to body pointer
B2AC B05D 2798 BCS BB30B ;if overflow, OUT OF MEMORY Error
B2AE 8559 2799 STA Z59 ;save pointer to end of body
B2BO A8 2800 TAY ;also in Y
B2B1 8A 2801 TXA
B2B2 6558 2802 ADC Z58 ;add low byte of length to body pointer
B2B4 9003 2803 BCC BB2B9 ;if overflow
B2B6 C8 2804 INY ;increment high byte
B2B7 F052 2805 BEQ BB30B ;if overflow, OUT OF MEMORY Error
B2B9 2008A4 2806 BB2B9 JSR SA408 ;check array area for overflow
B2BC 8531 2807 STA Z31
B2BE 8432 2808 STY Z32 ;set new end of array area
B2CO A900 2809 LDA $00
B2C2 E672 2810 INC Z72 ;get length
B2C4 A471 2811 LDY Z71
B2C6 F005 2812 BEQ BB2CD ;if low byte of length not zero

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B2C8 88      2813 BB2C8 DEY      ;decrement index
B2C9 9158    2814 STA (Z58),Y   ;store zero in array byte
B2CB DOFB    2815 BNE BB2C8     ;until low byte of length is zero
B2CD C659    2816 BB2CD DEC Z59  ;then set pointer to next block of 256
B2CF C672    2817 DEC Z72      ;and decrement high byte of length
B2D1 D0F5    2818 BNE BB2C8     ;repeat until length is zero
B2D3 E659    2819 INC Z59
B2D5 38      2820 SEC
B2D6 A531    2821 LDA Z31      ;get address of end of array area
B2D8 E55F    2822 SBC Z5F       ;minus pointer to array area
B2DA A002    2823 LDY $02
B2DC 915F    2824 STA (Z5F),Y  ;store low byte in + 2 of array header
B2DE A532    2825 LDA Z32      ;move high byte of difference
B2E0 C8      2826 INY
B2E1 E560    2827 SBC Z60
B2E3 915F    2828 STA (Z5F),Y  ;into + 3 of array header
B2E5 A50C    2829 LDA ZOC      ;if declaration
B2E7 D062    2830 BNE BB34B    ;then return
B2E9 C8      2831 INY         ;else point to declared # of dimentions
2832 ;
2833 ;compute reference to array element
2834 ;
B2EA B15F    2835 JB2EA LDA (Z5F),Y ;get # of dimensions from array header
B2EC 850B    2836 STA ZOB      ;save it
B2EE A900    2837 LDA $00
B2FO 8571    2838 STA Z71      ;initialize offset in body
B2F2 8572    2839 BB2F2 STA Z72
B2F4 C8      2840 INY
B2F5 68      2841 PLA         ;get low byte of index from stack
B2F6 AA      2842 TAX          ;into X
B2F7 8564    2843 STA Z64      ;and flp accu
B2F9 68      2844 PLA         ;get high byte of index from stack
B2FA 8565    2845 STA Z65      ;into A and flp accu
B2FC D15F    2846 CMP (Z5F),Y ;compare index to limit
B2FE 900E    2847 BCC BB30E    ;if lower, OK
B300 D006    2848 BNE BB308    ;if higher, BAD SUBSCRIPT Error
B302 C8      2849 INY         ;if equal
B303 8A      2850 TXA
B304 D15F    2851 CMP (Z5F),Y ;compare low bytes
B306 9007    2852 BCC BB30F    ;if lower, OK
B308 4C45B2  2853 BB308 JMP BB245 ;else BAD SUBSCRIPT Error
B30B 4C35A4  2854 BB30B JMP BA435 ;OUT OF MEMORY Error
2855 ;
B30E C8      2856 BB30E INY    ;if total index so far = 0
B30F A572    2857 BB30F LDA Z72
B311 0571    2858 ORA Z71
B313 18      2859 CLC
B314 F00A    2860 BEQ BB320    ;skip multiplication
B316 204CB3  2861 JSR SB34C    ;XY = offset * limit
B319 8A      2862 TXA
B31A 6564    2863 ADC Z64      ;add low byte of array index to A
B31C AA      2864 TAX
B31D 98      2865 TYA
B31E A422    2866 LDY Z22      ;restore index to array header
B320 6565    2867 BB320 ADC Z65 ;add high byte of array index to A
B322 8671    2868 STX Z71      ;save low byte of new offset
B324 C60B    2869 DEC ZOB      ;if not last index,
B326 D0CA    2870 BNE BB2F2    ;repeat for next index
B328 8572    2871 STA Z72      ;save high byte of offset
B32A A205    2872 LDX $05      ;set length per element for flp #

```

B32C A545	2873	LDA Z45	
B32E 1001	2874	BPL BB331	;if integer
B330 CA	2875	DEX	;correct length per element
B331 A546	2876	BB331 LDA Z46	
B333 1002	2877	BPL BB337	;if integer or string
B335 CA	2878	DEX	
B336 CA	2879	DEX	;correct length per element
B337 8628	2880	BB337 STX Z28	
B339 A900	2881	LDA \$00	
B33B 2055B3	2882	JSR SB355	;XY = offset * length per element
B33E 8A	2883	TXA	
B33F 6558	2884	ADC Z58	;add to pointer to array body
B341 8547	2885	STA Z47	;store result into variable address
B343 98	2886	TYA	
B344 6559	2887	ADC Z59	
B346 8548	2888	STA Z48	;high byte also
B348 A8	2889	TAY	
B349 A547	2890	LDA Z47	;return with AY = variable address
B34B 60	2891	BB34B RTS	

```

2893 ;XY = XA = length * limit from array data
2894 ;
B34C 8422 2895 SB34C STY Z22      ;save index in array header
B34E B15F 2896 LDA (Z5F),Y   ;get low byte of limit
B350 8528 2897 STA Z28      ;save it
B352 88    2898 DEY
B353 B15F 2899 LDA (Z5F),Y   ;get high byte of limit
B355 8529 2900 SB355 STA Z29    ;and save it too
B357 A910 2901 LDA $10      ;set # bits for multiplication
B359 855D 2902 STA Z5D
B35B A200 2903 LDX $00      ;initialize result fields
B35D A000 2904 LDY $00
B35F 8A    2905 BB35F TXA
B360 0A    2906 ASL A       ;XY * 2
B361 AA    2907 TAX
B362 98    2908 TYA
B363 2A    2909 ROL A
B364 A8    2910 TAY
B365 BOA4  2911 BCS BB30B    ;if overflow, OUT OF MEMORY Error
B367 0671  2912 ASL Z71
B369 2672  2913 ROL Z72    ;shift high bit out of length
B36B 900B  2914 BCC BB378
B36D 18    2915 CLC      ;if set
B36E 8A    2916 TXA
B36F 6528  2917 ADC Z28    ;add low byte of limit to XY
B371 AA    2918 TAX
B372 98    2919 TYA
B373 6529  2920 ADC Z29    ;high byte also
B375 A8    2921 TAY
B376 B093  2922 BCS BB30B    ;if overflow, OUT OF MEMORY Error
B378 C65D  2923 BB378 DEC Z5D
B37A DOE3  2924 BNE BB35F   ;repeat for all bits of length
B37C 60    2925 RTS

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```

2927 ; "FRE" command
2928 ;
B37D A50D 2929 WB37D LDA ZOD      ;if string flag set
B37F F003 2930 BEQ BB384
B381 20A6B6 2931 JSR SB6A6      ;de-allocate temporary string storage
B384 2026B5 2932 BB384 JSR SB526  ;perform garbage clean-up
B387 38   2933 SEC
B388 A533 2934 LDA Z33      ;compute difference between
B38A E531 2935 SBC Z31      ;pointer to allocated string area
B38C A8   2936 TAY      ;and pointer to end of array area
B38D A534 2937 LDA Z34
B38F E532 2938 SBC Z32      ;convert length into flp accu
2939 ;
2940 ;routine to convert integer to floating point
2941 ;
B391 A200 2942 JB391 LDX $00
B393 860D 2943 STX ZOD      ;clear string flag
B395 8562 2944 STA Z62      ;store integer from AY into flp accu
B397 8463 2945 STY Z63
B399 A290 2946 LDX $90      ;load exponent (16)
B39B 4C44BC 2947 JMP JBC44  ;convert to floating point #
2948 ;
2949 ;"POS" command
2950 ;
B39E 38   2951 WB39E SEC      ;set carry to read cursor position
B39F 20F0FF 2952 JSR XFFFF0  ;perform read cursor position into XY
B3A2 A900 2953 JB3A2 LDA $00
B3A4 FOEB 2954 BEQ JB391  ;convert integer into flp accu
2955 ;
2956 ;check for non-direct mode
2957 ;
B3A6 A63A 2958 SB3A6 LDX Z3A      ;get program/direct flag
B3A8 E8   2959 INX
B3A9 D0A0 2960 BNE BB34B  ;if direct,
B3AB A215 2961 LDX $15      ;point to ILLEGAL DIRECT Error message
B3AD 2C   2962 .BY $2C      ;skip next instruction
B3AE A21B 2963 BB3AE LDX $1B  ;point to UNDEF'D FUNCTION Error message
B3B0 4C37A4 2964 JMP JA437  ;print error

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2966 ;"DEF" command
2967 ;
B3B3 20E1B3 2968 WB3B3 JSR SB3E1      ;get function name
B3B6 20A6B3 2969 JSR SB3A6      ;check for non-direct mode
B3B9 20FAAE 2970 JSR SAEFA      ;next character must be "("
B3BC A980 2971 LDA $80
B3BE 8510 2972 STA Z10      ;set no integers/array elements allowed
B3C0 208BB0 2973 JSR SB08B      ;gather name and get pointer to variable
B3C3 208DAD 2974 JSR SAD8D      ;check value to be non-string
B3C6 20F7AE 2975 JSR SAEF7      ;next value must be ")"
B3C9 A9B2 2976 LDA $B2
B3CB 20FFAE 2977 JSR SAEFF      ;next character must be "="
B3CE 48 2978 PHA
B3CF A548 2979 LDA Z48      ;save first character of definition
B3D1 48 2980 PHA      ;save pointer to variable of function
B3D2 A547 2981 LDA Z47
B3D4 48 2982 PHA
B3D5 A57B 2983 LDA Z7B      ;save current character pointer
B3D7 48 2984 PHA
B3D8 A57A 2985 LDA Z7A
B3DA 48 2986 PHA
B3DB 20F8A8 2987 JSR JA8F8      ;execute command DATA
B3DE 4C4FB4 2988 JMP JB44F      ;set value for function name
2989 ;
2990 ;get function name
2991 ;
B3E1 A9A5 2992 SB3E1 LDA $A5      ;if next character not code for FN
B3E3 20FFAE 2993 JSR SAEFF      ;then SYNTAX Error
B3E6 0980 2994 ORA $80      ;else set bit 7 of
B3E8 8510 2995 STA Z10      ;no integers or array elements flag
B3EA 2092B0 2996 JSR SB092      ;gather name and get pointer to variable
B3ED 854E 2997 STA Z4E      ;save pointer to variable
B3EF 844F 2998 STY Z4F
B3F1 4C8DAD 2999 JMP SAD8D      ;check value to be non-string
3000 ;
3001 ;expand FN call
3002 ;
B3F4 20E1B3 3003 JB3F4 JSR SB3E1      ;get function name
B3F7 A54F 3004 LDA Z4F
B3F9 48 3005 PHA      ;save pointer to name on variable stack
B3FA A54E 3006 LDA Z4E
B3FC 48 3007 PHA
B3FD 20F1AE 3008 JSR BAEF1      ;get parenthesized value
B400 208DAD 3009 JSR SAD8D      ;check that value is non-string
B403 68 3010 PLA
B404 854E 3011 STA Z4E      ;restore pointer to variable name
B406 68 3012 PLA
B407 854F 3013 STA Z4F
B409 A002 3014 LDY $02
B40B B14E 3015 LDA (Z4E),Y      ;get index to variable
B40D 8547 3016 STA Z47      ;save pointer to formal parameters
B40F AA 3017 TAX
B410 C8 3018INY
B411 B14E 3019 LDA (Z4E),Y      ;high byte also
B413 F099 3020 BEQ BB3AE      ;if data byte + 3 is zero, fatal error
B415 8548 3021 STA Z48
B417 C8 3022INY
B418 B147 3023 BB418 LDA (Z47),Y      ;save formal parameters on stack
B41A 48 3024 PHA
B41B 88 3025 DEY

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B41C 10FA	3026	BPL BB418	
B41E A448	3027	LDY Z48	;get pointer to formal parameters in XY
B420 20D4BB	3028	JSR SBB04	;store flp accu into formal parameters
B423 A57B	3029	LDA Z7B	
B425 48	3030	PHA	;save current character pointer on stack
B426 A57A	3031	LDA Z7A	
B428 48	3032	PHA	
B429 B14E	3033	LDA (Z4E),Y	;move current pointer of definition
B42B 857A	3034	STA Z7A	;into current character pointer
B42D C8	3035	INY	
B42E B14E	3036	LDA (Z4E),Y	
B430 857B	3037	STA Z7B	
B432 A548	3038	LDA Z48	
B434 48	3039	PHA	
B435 A547	3040	LDA Z47	
B437 48	3041	PHA	
B438 208AAD	3042	JSR SAD8A	;get next non-string value
B43B 68	3043	PLA	;set pointer to formal parameters
B43C 854E	3044	STA Z4E	
B43E 68	3045	PLA	
B43F 854F	3046	STA Z4F	
B441 207900	3047	JSR X0079	;get current character
B444 F003	3048	BEQ BB449	;if not zero or ":"
B446 4C08AF	3049	JMP JAF08	;SYNTAX Error
	3050 ;		
B449 68	3051 BB449	PLA	
B44A 857A	3052	STA Z7A	;restore current character pointer
B44C 68	3053	PLA	
B44D 857B	3054	STA Z7B	;and restore formal parameters
B44F A000	3055 JB44F	LDY \$00	;set index into variable
B451 68	3056	PLA	
B452 914E	3057	STA (Z4E),Y	;save stack into variable, byte + 0
B454 68	3058	PLA	
B455 C8	3059	INY	
B456 914E	3060	STA (Z4E),Y	;byte + 1
B458 68	3061	PLA	
B459 C8	3062	INY	
B45A 914E	3063	STA (Z4E),Y	;byte + 2
B45C 68	3064	PLA	
B45D C8	3065	INY	
B45E 914E	3066	STA (Z4E),Y	;byte + 3
B460 68	3067	PLA	
B461 C8	3068	INY	
B462 914E	3069	STA (Z4E),Y	;byte + 4
B464 60	3070	RTS	

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3072 ;"STR$" command
3073 ;
B465 208DAD 3074 WB465 JSR SAD8D ;check if parameter non-string
B468 A000 3075 LDY $00 ;start output area at $00FF
B46A 20DFBD 3076 JSR SBDDF ;convert to string
B46D 68 3077 PLA ;remove own return address
B46E 68 3078 PLA
B46F A9FF 3079 JB46F LDA $FF ;set AY to point to string
B471 A000 3080 LDY $00 ;on bottom of stack
B473 F012 3081 BEQ SB487 ;get description of constant string
B475 A664 3082 SB475 LDX Z64 ;move pointer to string description
B477 A465 3083 LDY Z65
B479 8650 3084 STX Z50 ;into Z50/Z51
B47B 8451 3085 STY Z51
3086 ;
3087 ;allocate area according to A
3088 ;
B47D 20F4B4 3089 SB47D JSR SB4F4 ;allocate area
B480 8662 3090 STX Z62 ;store pointer
B482 8463 3091 STY Z63
B484 8561 3092 STA Z61 ;store length
B486 60 3093 RTS

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3095 ;get description of constant string into flp accu
3096 ;
B487 A222 3097 SB487 LDX ""
B489 8607 3098 STX Z07      ;set both terminators
B48B 8608 3099 STX Z08
B48D 856F 3100 SB48D STA Z6F      ;store pointer to beginning of string
B48F 8470 3101 STY Z70      ;in temporary pointer
B491 8562 3102 STA Z62      ;and in flp accu
B493 8463 3103 STY Z63
B495 A0FF 3104 LDY $FF      ;initialize string index
B497 C8   3105 BB497 INY
B498 B16F 3106 LDA (Z6F),Y ;get next character
B49A F00C 3107 BEQ BB4A8 ;if zero
B49C C507 3108 CMP Z07
B49E F004 3109 BEQ BB4A4 ;or first terminator,
B4A0 C508 3110 CMP Z08
B4A2 D0F3 3111 BNE BB497 ;or second terminator, then end found
B4A4 C922 3112 BB4A4 CMP "" ;if terminator = quote
B4A6 F001 3113 BEQ BB4A9
B4A8 18   3114 BB4A8 CLC
B4A9 8461 3115 BB4A9 STY Z61 ;save length
B4AB 98   3116 TYA
B4AC 656F 3117 ADC Z6F
B4AE 8571 3118 STA Z71 ;and set pointer beyond string
B4B0 A670 3119 LDX Z70
B4B2 9001 3120 BCC BB4B5
B4B4 E8   3121 INX
B4B5 8672 3122 BB4B5 STX Z72
B4B7 A570 3123 LDA Z70 ;if from statement in Direct mode,
B4B9 F004 3124 BEQ BB4BF
B4BB C902 3125 CMP $02
B4BD D00B 3126 BNE BB4CA
B4BF 98   3127 BB4BF TYA ;get length
B4C0 2075B4 3128 JSR SB475 ;allocate area
B4C3 A66F 3129 LDX Z6F
B4C5 A470 3130 LDY Z70 ;save pointer to it
B4C7 2088B6 3131 JSR SB688 ;move string into it

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3133 ;save descriptor from Z61-Z63 to descriptor stack
3134 ;
B4CA A616 3135 BB4CA LDX Z16      ;get descriptor stack index
B4CC E022 3136 CPX <Z22      ;if at $22
B4CE D005 3137 BNE BB4D5
B4DO A219 3138 LDX $19      ;point to FORMULA TOO COMPLEX Error
B4D2 4C37A4 3139 BB4D2 JMP JA437 ;print error
B4D5 A561 3140 BB4D5 LDA Z61      ;else move descriptor
B4D7 9500 3141 STA Z00,X      ;to descriptor stack
B4D9 A562 3142 LDA Z62
B4DB 9501 3143 STA Z01,X
B4DD A563 3144 LDA Z63
B4DF 9502 3145 STA Z02,X
B4E1 A000 3146 LDY $00      ;set pointer to descriptor
B4E3 8664 3147 STX Z64      ;in flp accu
B4E5 8465 3148 STY Z65
B4E7 8470 3149 STY Z70      ;clear guard bit
B4E9 88   3150 DEY
B4EA 840D 3151 STY Z0D      ;set string flag
B4EC 8617 3152 STX Z17      ;set previous descriptor stack index
B4EE E8   3153 INX
B4EF E8   3154 INX
B4F0 E8   3155 INX
B4F1 8616 3156 STX Z16      ;set new descriptor stack index
B4F3 60   3157 RTS

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3159 ;allocate # of bytes in A
3160 ;
B4F4 460F 3161 SB4F4 LSR ZOF      ;clear error flag
B4F6 48    3162 BB4F6 PHA      ;save length
B4F7 49FF 3163 EOR $FF
B4F9 38    3164 SEC
B4FA 6533 3165 ADC Z33      ;subtract length from string storage ptr
B4FC A434 3166 LDY Z34
B4FE B001 3167 BCS BB501
B500 88    3168 DEY      ;high byte also
B501 C432 3169 BB501 CPY Z32      ;if above
B503 9011 3170 BCC BB516      ;array area
B505 D004 3171 BNE BB50B
B507 C531 3172 CMP Z31
B509 900B 3173 BCC BB516
B50B 8533 3174 BB50B STA Z33      ;set new string storage pointer
B50D 8434 3175 STY Z34
B50F 8535 3176 STA Z35      ;set utility string pointer also
B511 8436 3177 STY Z36
B513 AA    3178 TAX      ;and set AX
B514 68    3179 PLA      ;restore length
B515 60    3180 RTS
            3181 ;
B516 A210 3182 BB516 LDX $10
B518 A50F 3183 LDA Z0F      ;if no memory left
B51A 30B6 3184 BMI BB4D2      ;print OUT OF MEMORY Error
B51C 2026B5 3185 JSR SB526      ;else perform garbage clean-up
B51F A980 3186 LDA $80
B521 850F 3187 STA Z0F      ;clear flag
B523 68    3188 PLA      ;restore # bytes to allocate
B524 DODO 3189 BNE BB4F6      ;and perform allocation
            3190 ;
            3191 ;string garbage clean-up
            3192 ;
B526 A637 3193 SB526 LDX Z37      ;get memory limit
B528 A538 3194 LDA Z38
B52A 8633 3195 JB52A STA Z33      ;set new string storage pointer
B52C 8534 3196 STA Z34
B52E A000 3197 LDY $00      ;set no decriptor of highest text yet
B530 844F 3198 STY Z4F
B532 844E 3199 STY Z4E
B534 A531 3200 LDA Z31      ;get end of array area
B536 A632 3201 LDX Z32
B538 855F 3202 STA Z5F      ;initialize value for higheat text ptr
B53A 8660 3203 STX Z60
B53C A919 3204 LDA <Z19      ;AX = ptr to bottom of descriptor stack
B53E A200 3205 LDX >Z19
B540 8522 3206 STA Z22      ;and atore in temporary pointer
B542 8623 3207 STX Z23
B544 C516 3208 BB544 CMP Z16
B546 F005 3209 BEQ BB54D      ;if not top index of descriptor stack
B548 20C7B5 3210 JSR SB5C7      ;find highest text area
B54B F0F7 3211 BEQ BB544
B54D A907 3212 BB54D LDA $07      ;set step to 7
B54F 8553 3213 STA Z53
B551 A52D 3214 LDA Z2D      ;move pointer to name table
B553 A62E 3215 LDX Z2E
B555 8522 3216 STA Z22      ;into temporary pointer
B557 8623 3217 STX Z23
B559 E430 3218 B8559 CPX Z30

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B55B D004	3219	BNE BB561	;if end of name table
B55D C52F	3220	CMP Z2F	;not reached yet
B55F F005	3221	BEQ BB566	
B561 20DBD5	3222	BB561 JSR SB5BD	;find highest text area
B564 F0F3	3223	BEQ BB59	
B566 8558	3224	BB566 STA Z58	;save pointer into array area
B568 8659	3225	STX Z59	
B56A A903	3226	LDA \$03	;reset step to 3
B56C 8553	3227	STA Z53	
B56E A558	3228	BB56E LDA Z58	;get pointer to next array
B570 A659	3229	LDX Z59	
B572 E432	3230	BB572 CPX Z32	
B574 D007	3231	BNE BB57D	;if end of array area
B576 C531	3232	CMP Z31	
B578 D003	3233	BNE BB57D	
B57A 4C06B6	3234	JMP JB606	;move text area
B57D 8522	3235	BB57D STA Z22	;else save array pointer
B57F 8623	3236	STX Z23	;into temporary pointer
B581 A000	3237	LDY \$00	
B583 B122	3238	LDA (Z22),Y	
B585 AA	3239	TAX	;save first character of name
B586 C8	3240	INY	
B587 B122	3241	LDA (Z22),Y	
B589 08	3242	PHP	;save status of second character of name
B58A C8	3243	INY	
B58B B122	3244	LDA (Z22),Y	;add length of array
B58D 6558	3245	ADC Z58	
B58F 8558	3246	STA Z58	;to array pointer
B591 C8	3247	INY	
B592 B122	3248	LDA (Z22),Y	
B594 6559	3249	ADC Z59	;high byte also
B596 8559	3250	STA Z59	
B598 28	3251	PLP	;second character of variable name
B599 10D3	3252	BPL BB56E	;must have bit 7 set for string
B59B 8A	3253	TXA	;first character of variable name
B59C 30D0	3254	BMI BB56E	;must have bit 7 low for string
B59E C8	3255	INY	
B59F B122	3256	LDA (Z22),Y	;get # of dimensions
B5A1 A000	3257	LDY \$00	;and initialize Y
B5A3 0A	3258	ASL A	;compute offset to first element
B5A4 6905	3259	ADC \$05	
B5A6 6522	3260	ADC Z22	
B5A8 8522	3261	STA Z22	
B5AA 9002	3262	BCC BB5AE	
B5AC E623	3263	INC Z23	
B5AE A623	3264	BB5AE LDX Z23	
B5B0 E459	3265	BB5B0 CPX Z59	;if not pointing beyond last element
B5B2 D004	3266	BNE BB5B8	
B5B4 C558	3267	CMP Z58	
B5B6 F0BA	3268	BEQ BB572	
B5B8 20C7B5	3269	BB5B8 JSR SB5C7	;find highest text address
B5BB F0F3	3270	BEQ BB5B0	;and repeat for next address

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3272 ;check string pointed to by Z22/Z23
3273 ;as being highest string area outside allocated area
3274 ;
B5BD B122 3275 SB5BD LDA (Z22),Y ;if name has bit 7 of first char = 0
B5BF 3035 3276 BMI BB5F6
B5C1 C8 3277 INY
B5C2 B122 3278 LDA (Z22),Y ;and bit 7 of second character = 1
B5C4 1030 3279 BPL BB5F6
B5C6 C8 3280 INY ;drop thru
3281 ;
3282 ;check string indexed by descriptor
3283 ;for being highest string area
3284 ;outside of allocated area
3285 ;
B5C7 B122 3286 SB5C7 LDA (Z22),Y ;if length = 0
B5C9 F02B 3287 BEQ BB5F6 ;then no text area
B5CB C8 3288 INY
B5CC B122 3289 LDA (Z22),Y
B5CE AA 3290 TAX ;get pointer to text into AX
B5CF C8 3291 INY
B5D0 B122 3292 LDA (Z22),Y
B5D2 C534 3293 CMP Z34 ;if pointer is
B5D4 9006 3294 BCC BB5DC ;above string storage area
B5D6 D01E 3295 BNE BB5F6
B5D8 E433 3296 CPX Z33
B5DA B01A 3297 BCS BB5F6 ;then string is not highest
B5DC C560 3298 BB5DC CMP Z60 ;if pointer is
B5DE 9016 3299 BCC BB5F6 ;below previous highest
B5E0 D004 3300 BNE BB5E6
B5E2 E45F 3301 CPX Z5F
B5E4 9010 3302 BCC BB5F6 ;then not highest
B5E6 865F 3303 BB5E6 STX Z5F
B5E8 8560 3304 STA Z60 ;save pointer to new highest
B5EA A522 3305 LDA Z22
B5EC A623 3306 LDX Z23 ;get pointer to variable or descriptor
B5EE 854E 3307 STA Z4E
B5FO 864F 3308 STX Z4F ;save pointer to winner
B5F2 A553 3309 LDA Z53 ;save step size of winner
B5F4 8555 3310 STA Z55
B5F6 A553 3311 BB5F6 LDA Z53 ;add step
B5F8 18 3312 CLC
B5F9 6522 3313 ADC Z22 ;to variable or descriptor pointer
B5FB 8522 3314 STA Z22
B5FD 9002 3315 BCC BB601
B5FF E623 3316 INC Z23
B601 A623 3317 BB601 LDX Z23 ;variable or descriptor pointer in AX
B603 A000 3318 LDY $00
B605 60 3319 RTS

```

```

3321 ;continuation of string garbage clean-up
3322 ;
B606 A54F 3323 JB606 LDA Z4F      ;if no pointer to descriptor
B608 054E 3324 ORA Z4E       ;of highest string yet,
B60A F0F5 3325 BEQ BB601    ;return
B60C A555 3326 LDA Z55
B60E 2904 3327 AND $04      ;compute offset to descriptor
B610 4A   3328 LSR A
B611 A8   3329 TAY
B612 8555 3330 STA Z55
B614 B14E 3331 LDA (Z4E),Y ;get length of text
B616 655F 3332 ADC Z5F      ;add to pointer to beginning of text
B618 855A 3333 STA Z5A      ;store in high limit for move routine
B61A A560 3334 LDA Z60      ;high bytes also
B61C 6900 3335 ADC $00
B61E 855B 3336 STA Z5B
B620 A533 3337 LDA Z33      ;move current string storage pointer
B622 A634 3338 LDX Z34
B624 8558 3339 STA Z58      ;into high limit of output for move
B626 8659 3340 STX Z59
B628 20BFA3 3341 JSR SA3BF    ;move bytes
B62B A455 3342 LDY Z55      ;get offset to descriptor
B62D C8   3343 INY
B62E A558 3344 LDA Z58
B630 914E 3345 STA (Z4E),Y ;let descriptor point to moved text area
B632 AA   3346 TAX
B633 E659 3347 INC Z59
B635 A559 3348 LDA Z59
B637 C8   3349 INY
B638 914E 3350 STA (Z4E),Y ;high byte also
B63A 4C2AB5 3351 JMP JB52A    ;repeat for next string

```

```

3353 ;diadic operator "+" for strings
3354 ;
B63D A565 3355 JB63D LDA Z65
B63F 48    3356 PHA          ;save pointer to left operand
B640 A564 3357 LDA Z64
B642 48    3358 PHA
B643 2083AE 3359 JSR SAE83 ;get value of next operand in flp accu
B646 208FAD 3360 JSR SAD8F ;must be string
B649 68    3361 PLA
B64A 856F  3362 STA Z6F
B64C 68    3363 PLA
B64D 8570  3364 STA Z70   ;restore temporary string address
B64F A000  3365 LDY $00
B651 B16F  3366 LDA (Z6F),Y ;get length of left operand
B653 18    3367 CLC
B654 7164  3368 ADC (Z64),Y ;add length of right operand
B656 9005  3369 BCC BB65D ;if => 256
B658 A217  3370 LDX $17   ;point to STRING TOO LONG Error
B65A 4C37A4 3371 JMP JA437 ;print error
                            3372 ;
B65D 2075B4 3373 BB65D JSR SB475 ;allocate area for sum of lengths
B660 207AB6 3374 JSR SB67A ;move left operand
B663 A550  3375 LDA Z50
B665 A451  3376 LDY Z51   ;get descriptor of right operand
B667 20AAB6 3377 JSR SB6AA ;de-allocate old area
B66A 208CB6 3378 JSR SB68C ;move right operand
B66D A56F  3379 LDA Z6F
B66F A470  3380 LDY Z70
B671 20AAB6 3381 JSR SB6AA ;de-allocate old area
B674 20CAB4 3382 JSR BB4CA ;save descriptor on stack
B677 4CB8AD 3383 JMP JADB8 ;go back to expression evaluation

```

```

3385 ;move string with descriptor pointed by Z6F/Z70
3386 ;into last allocated area
3387 ;
B67A A000 3388 SB67A LDY $00
B67C B16F 3389 LDA (Z6F),Y
B67E 48 3390 PHA ;save length from descriptor
B67F C8 3391 INY
B680 B16F 3392 LDA (Z6F),Y
B682 AA 3393 TAX ;pointer from descriptor
B683 C8 3394 INY
B684 B16F 3395 LDA (Z6F),Y
B686 A8 3396 TAY ;into XY
B687 68 3397 PLA ;length into A
3398 ;
3399 ;move string with length in A, pointer in XY
3400 ;into last allocated area
3401 ;
B688 8622 3402 SB688 STX Z22 ;save pointer in temporary pointer area
B68A 8423 3403 STY Z23
B68C A8 3404 SB68C TAY ;if length = 0
B68D F00A 3405 BEQ BB699 ;don't move
B68F 48 3406 PHA ;save length
B690 88 3407 BB690 DEY ;for every character
B691 B122 3408 LDA (Z22),Y ;move from string
B693 9135 3409 STA (Z35),Y ;to last allocated area
B695 98 3410 TYA
B696 DOF8 3411 BNE BB690 ;until no more characters
B698 68 3412 PLA ;restore length
B699 18 3413 BB699 CLC ;set Z35/Z36 to end of allocated area
B69A 6535 3414 ADC Z35
B69C 8535 3415 STA Z35
B69E 9002 3416 BCC BB6A2
B6A0 E636 3417 INC Z36
B6A2 60 3418 BB6A2 RTS

```

```

3420 ;de-allocate a temporary string
3421 ;
B6A3 208FAD 3422 SB6A3 JSR SAD8F      ;check if value is a string
B6A6 A564 3423 SB6A6 LDA Z64
B6AB A465 3424 LDY Z65      ;set AY to pointer to descriptor
B6AA 8522 3425 SB6AA STA Z22      ;and store in temporary pointer
B6AC 8423 3426 STY Z23
B6AE 20DBB6 3427 JSR SB6DB      ;check descriptor stack
B6B1 08 3428 PHP      ;save status (Z=1 when desc on stack)
B6B2 A000 3429 LDY $00
B6B4 B122 3430 LDA (Z22),Y
B6B6 48 3431 PHA      ;save string length
B6B7 C8 3432 INY
B6B8 B122 3433 LDA (Z22),Y
B6BA AA 3434 TAX      ;pointer to string in XY
B6BB C8 3435 INY
B6BC B122 3436 LDA (Z22),Y
B6BE A8 3437 TAY
B6BF 68 3438 PLA      ;string length into A
B6C0 28 3439 PLP      ;restore status
B6C1 D013 3440 BNE BB6D6      ;branch if descriptor on stack
B6C3 C434 3441 CPY Z34      ;if pointer to string
B6C5 D00F 3442 BNE BB6D6
B6C7 E433 3443 CPX Z33      ;= string storage pointer
B6C9 D00B 3444 BNE BB6D6
B6CB 48 3445 PHA      ;save length
B6CC 18 3446 CLC
B6CD 6533 3447 ADC Z33      ;add length to string storage pointer
B6CF 8533 3448 STA Z33      ;to form new string storage pointer
B6D1 9002 3449 BCC BB6D5      ;(de-allocates string)
B6D3 E634 3450 INC Z34
B6D5 68 3451 BB6D5 PLA      ;restore length
B6D6 8622 3452 BB6D6 STX Z22      ;save pointer to string
B6D8 8423 3453 STY Z23
B6DA 60 3454 RTS
3455 ;
3456 ;check descriptor stack
3457 ;
B6DB C418 3458 SB6DB CPY Z18
B6DD D00C 3459 BNE BB6EB      ;if descriptor pointer
B6DF C517 3460 CMP Z17      ;same as previous descriptor stack ptr
B6E1 D008 3461 BNE BB6EB
B6E3 8516 3462 STA Z16      ;then set descriptor stack index
B6E5 E903 3463 SBC $03      ;to point to it
B6E7 8517 3464 STA Z17      ;set previous descriptor index below it
B6E9 A000 3465 LDY $00      ;leave new descriptor pointer in AY
B6EB 60 3466 BB6EB RTS

```

```

3468 ;"CHR$" command
3469 ;
B6EC 20A1B7 3470 WB6EC JSR SB7A1 ;get integer parameter into X
B6EF 8A 3471 TXA
B6F0 48 3472 PHA ;and save
B6F1 A901 3473 LDA $01 ;set length
B6F3 207DB4 3474 JSR SB47D ;allocate area
B6F6 68 3475 PLA ;restore integer
B6F7 A000 3476 LDY $00
B6F9 9162 3477 STA (Z62),Y ;save character in allocated area
B6FB 68 3478 PLA
B6FC 68 3479 PLA ;remove own return address
B6FD 4CCAB4 3480 JMP BB4CA ;save descriptor on descriptor stack
3481 ;
3482 ;"LEFT$" command
3483 ;
B700 2061B7 3484 WB700 JSR SB761 ;get 2 parameters
B703 D150 3485 CMP (Z50),Y ;compare length wanted to stack length
B705 98 3486 TYA ;A = initial index in text
B706 9004 3487 JB706 BCC BB70C ;if length requested >= string length
B708 B150 3488 LDA (Z50),Y
B70A AA 3489 TAX ;use string length instead
B70B 98 3490 TYA
B70C 48 3491 BB70C PHA ;save initial index
B70D 8A 3492 BB70D TXA ;get length wanted
B70E 48 3493 BB70E PHA ;and save it
B70F 207DB4 3494 JSR SB47D ;de-allocate area
B712 A550 3495 LDA Z50
B714 A451 3496 LDY Z51 ;set AY to point to first parameter
B716 20AAB6 3497 JSR SB6AA ;de-allocate temporary string
B719 68 3498 PLA ;restore length requested
B71A A8 3499 TAY
B71B 68 3500 PLA ;restore initial index in text
B71C 18 3501 CLC
B71D 6522 3502 ADC Z22 ;add to text pointer
B71F 8522 3503 STA Z22
B721 9002 3504 BCC BB725
B723 E623 3505 INC Z23
B725 98 3506 BB725 TYA ;for length requested,
B726 208CB6 3507 JSR SB68C ;move string into allocated area
B729 4CCAB4 3508 JMP BB4CA ;save descriptor on descriptor stack
3509 ;
3510 ;"RIGHT$" command
3511 ;
B72C 2061B7 3512 WB72C JSR SB761 ;get 2 parameters
B72F 18 3513 CLC
B730 F150 3514 SBC (Z50),Y ;compute length - length requested
B732 49FF 3515 EOR $FF
B734 4C06B7 3516 JMP JB706 ;go do tail end of LEFT$

```

```

3518 ;"MID$" command
3519 ;
B737 A9FF 3520 WB737 LDA $FF      ;set default 3rd parameter to 255
B739 8565 3521 STA Z65
B73B 207900 3522 JSR X0079      ;get current character
B73E C929 3523 CMP ')          ;if not ")"
B740 F006 3524 BEQ BB748
B742 20FDAE 3525 JSR SAEFD      ;must be ","
B745 209EB7 3526 JSR SB79E      ;get next integer
B748 2061B7 3527 BB748 JSR SB761  ;get first 2 parameters
B74B F04B 3528 BEQ BB79B      ;if 2nd parameter = 0, ILLEGAL QUANTITY
B74D CA   3529 DEX             ;decrement index
B74E 8A   3530 TXA
B74F 48   3531 PHA             ;and save it on stack
B750 18   3532 CLC
B751 A200 3533 LDX $00
B753 F150 3534 SBC (Z50),Y    ;compute index - length
B755 B0B6 3535 BCS BB70D      ;if larger, get null string
B757 49FF 3536 EOR $FF        ;if # characters remaining
B759 C565 3537 CMP Z65
B75B 90B1 3538 BCC BB70E      ;less than 3rd parameter,
B75D A565 3539 LDA Z65        ;take # of characters remaining instead
B75F BOAD 3540 BCS BB70E      ;do tail end of LEFT$  

3541 ;
3542 :get first two parameters for LEFT$, RIGHT$ and MID$  

3543 ;
B761 20F7AE 3544 SB761 JSR SAEF7  ;next character must be ")"
B764 68   3545 PLA
B765 AB   3546 TAY             ;save return address
B766 68   3547 PLA
B767 B555 3548 STA Z55
B769 68   3549 PLA             ;remove return address
B76A 68   3550 PLA
B76B 68   3551 PLA             ;restore 2nd parameter (integer)
B76C AA   3552 TAX
B76D 68   3553 PLA
B76E B550 3554 STA Z50        ;move 1st parameter (ptr to descriptor)
B770 6B   3555 PLA             ;into Z50/Z51
B771 8551 3556 STA Z51
B773 A555 3557 LDA Z55
B775 48   3558 PHA             ;restore return address
B776 98   3559 TYA
B777 48   3560 PHA
B77B A000 3561 LDY $00
B77A 8A   3562 TXA             ;set flags according to 2nd parameter
B77B 60   3563 RTS

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```

3565 ;"LEN " command
3566 ;
B77C 2082B7 3567 WB77C JSR SB782 ;de-allocate parameter, get length in Y
B77F 4CA2B3 3568 JMP JB3A2 ;convert integer in Y to flp
3569 ;
B782 20A3B6 3570 SB782 JSR SB6A3 ;de-allocate temp string (parameter)
B785 A200 3571 LDX $00
B787 860D 3572 STX ZOD ;reset string flag
B789 A8 3573 TAY ;move length to Y
B78A 60 3574 RTS
3575 ;
3576 ;"ASC " command
3577 ;
B78B 2082B7 3578 WB78B JSR SB782 ;de-allocate parameter, get length in Y
B78E F008 3579 BEQ BB798 ;if null string, ILLEGAL QUANTITY Error
B790 A000 3580 LDY $00
B792 B122 3581 LDA (Z22),Y ;get first character of string
B794 A8 3582 TAY ;move into Y
B795 4CA2B3 3583 JMP JB3A2 ;convert integer in Y to flp
3584 ;
B798 4C48B2 3585 BB798 JMP JB248 ; print error
3586 ;
3587 ;fetch integer value in X and check range
3588 ;
B79B 207300 3589 SB79B JSR X0073 ;get next character
B79E 208AAD 3590 SB79E JSR SAD8A ;get next non-string value
B7A1 20B8B1 3591 SB7A1 JSR SB1B8 ;convert positive flp accu to integer
B7A4 A664 3592 LDX Z64 ;if not in range 0 - 255
B7A6 DOFO 3593 BNE BB798 ;print error ILLEGAL QUANTITY
B7A8 A665 3594 LDX Z65 ;load value into X
B7AA 4C7900 3595 JMP X0079 ;get current character again and return

```

```

3597 ; "VAL" command
3598 ;
B7AD 2082B7 3599 WB7AD JSR SB782      ;de-allocate parameter, get length in Y
B7B0 D003   3600     BNE BB7B5
B7B2 4CF7B8  3601     JMP JB8F7
B7B5 A67A   3602 BB7B5 LDX Z7A
B7B7 A47B   3603     LDY Z7B
B7B9 8671   3604     STX Z71
B7BB 8472   3605     STY Z72
B7BD A622   3606     LDX Z22
B7BF 867A   3607     STX Z7A
B7C1 18    3608     CLC
B7C2 6522   3609     ADC Z22
B7C4 8524   3610     STA Z24
B7C6 A623   3611     LDX Z23
B7C8 867B   3612     STX Z7B
B7CA 9001   3613     BCC BB7CD
B7CC E8    3614     INX
B7CD 8625   3615 BB7CD STX Z25      ;add length
B7CF A000   3616     LDY $00      ;to create pointer to end of string
B7D1 B124   3617     LDA (224),Y  ;move high byte of text pointer
B7D3 48    3618     PHA
B7D4 98    3619     TYA
B7D5 9124   3620     STA (224),Y  ;into current character ptr
B7D7 207900 3621     JSR X0079
B7DA 20F3BC 3622     JSR SBCF3
B7DD 68    3623     PLA
B7DE A000   3624     LDY $00
B7EO 9124   3625     STA (224),Y  ;set null instead
B7E2 A671   3626 SB7E2 LDX Z71      ;get current character
B7E4 A472   3627     LDY Z72      ;convert string to flp
B7E6 867A   3628     STX Z7A      ;restore first byte beyond string
B7E8 847B   3629     STY Z7B
B7EA 60    3630     RTS
3631 ;
3632 ;get address into Z14/Z15 and integer into X
3633 ;
B7EB 208AAD 3634 SB7EB JSR SAD8A      ;and store it as current character ptr
B7EE 20F7B7  3635     JSR SB7F7      ;get non-string value from statement
B7F1 20FDAE 3636 SB7F1 JSR SAEFD    ;convert flp accu to integer at Z14/Z15
B7F4 4C9EB7  3637     JMP SB79E     ;next character must be ","
                                         ;get next integer from statement into X

```

```

3639 ;convert floating point into integer in Z14/Z15
3640 ;
B7F7 A566 3641 SB7F7 LDA Z66      ;if negative
B7F9 309D 3642 BMI BB798
B7FB A561 3643 LDA Z61
B7FD C991 3644 CMP $91      ;or exponent > 16
B7FF B097 3645 BCS BB798      ;then ILLEGAL QUANTITY Error
B801 209BBC 3646 JSR SBC9B      ;convert flp accu to integer at Z64/Z65
B804 A564 3647 LDA Z64
B806 A465 3648 LDY Z65
B808 8414 3649 STY Z14      ;and into result field
B80A 8515 3650 STA Z15
B80C 60   3651 RTS
            3652 ;
            3653 ;"PEEK" command
            3654 ;
B80D A515 3655 WB80D LDA Z15
B80F 48   3656 PHA
B810 A514 3657 LDA Z14      ;save contents of Z14/Z15
B812 48   3658 PHA
B813 20F7B7 3659 JSR SB7F7      ;convert flp accu to integer in Z14/Z15
B816 A000 3660 LDY $00
B818 B114 3661 LDA (Z14),Y  ;get byte
B81A A8   3662 TAY      ;and save in Y
B81B 68   3663 PLA      ;then restore Z14/Z15
B81C 8514 3664 STA Z14
B81E 68   3665 PLA
B81F 8515 3666 STA Z15
B821 4CA2B3 3667 JMP JB3A2      ;convert integer in Y to flp
            3668 ;
            3669 ;"POKE" command
            3670 ;
B824 20EBB7 3671 WB824 JSR SB7EB      ;get address in Z14/Z15, integer in X
B827 8A   3672 TXA
B828 A000 3673 LDY $00
B82A 9114 3674 STA (Z14),Y  ;move integer from X to address
B82C 60   3675 RTS

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```

3677 ;"WAIT" command
3678 ;
B82D 20EBB7 3679 WB82D JSR SB7EB      ;get address in Z14/Z15, integer in X
B830 8649   3680   STX Z49           ;save mask
B832 A200   3681   LDX $00          ;default pattern = 00
B834 207900 3682   JSR X0079      ;get current character
B837 F003   3683   BEQ BB83C      ;if not end of statement
B839 20FLB7 3684   JSR SB7F1      ;get next integer from statement into X
B83C 864A   3685 BB83C STX Z4A      ;save pattern
B83E A000   3686   LDX $00          ;get byte
B840 B114   3687 BB840 LDA (Z14),Y    ;get byte
B842 454A   3688   EOR Z4A          ;Exclusive OR with pattern
B844 2549   3689   AND Z49          ;mask
B846 FOF8   3690   BEQ BB840      ;repeat until non-zero
B848 60     3691 BB848 RTS
3692 ;
3693 ;add 0.5 to flp accu (half rounding)
3694 ;
B849 A911   3695 SB849 LDA <TBF11
B84B A0BF   3696   LDY >TBF11      ;set AY to point to value 0.5
B84D 4C67B8 3697   JMP SB867      ;add to flp accu
3698 ;
3699 ;"MINUS" operator
3700 ;
B850 208CBA 3701 SB850 JSR SBA8C      ;subtract flp accu from # indexed by AY
3702 ;
3703 ;diadic operator "-"
3704 ;
B853 A566   3705 WB853 LDA Z66
B855 49FF   3706   EOR $FF          ;complement sign
B857 8566   3707   STA Z66
B859 456E   3708   EOR Z6E
B85B 856F   3709   STA Z6F          ;also adjust Exclusive OR of both signs
B85D A561   3710   LDA Z61          ;fetch exponent of flp accu
B85F 4C6AB8 3711   JMP JB86A      ;go apply diadic operator "+"

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```

B862 2099B9 3713 BB862 JSR SB999      ;perform preshifts according to A
B865 903C    3714     BCC BB8A3       ;do addition or subtraction
3715 ;
3716 ;add flp # indexed by AY to flp accu
3717 ;
B867 208CBA 3718 SB867 JSR S8A8C      ;perform addition
3719 ;
3720 ;"PLUS" operator
3721 ;
B86A        3722 WB86A =   *             ;if flp accu = 0
B86A D003    3723 JB86A BNE BB86F      ;move 2nd flp accu into flp accu
B86C 4CFCBB  3724     JMP SBBFC
3725 ;
B86F A670    3726 BB86F LDX Z70      ;save guard bit
B871 8656    3727     STX Z56
8873 A269    3728     LDX $69      ;X = pointer to smaller
8875 A569    3729     LDA Z69      ;get exponent of 2nd flp accu
B877 A8      3730 SB877 TAY      ;if zero
B878 FOCE    3731     BEQ BB848      ;result already in flp accu
887A 38      3732     SEC
B87B E561    3733     S8C Z61      ;compute difference in exponents
B87D F024    3734     BEQ BB8A3      ;if zero, go act on fractions
B87F 9012    3735     BCC BB893      ;if second flp accu higher
B881 8461    3736     STY Z61      ;set exponent of result
B883 A46E    3737     LDY Z6E      ;and sign of result
B885 8466    3738     STY Z66
B887 49FF    3739     EOR $FF      ;two's complement of difference
B889 6900    3740     ADC $00
B88B A000    3741     LDY $00
B88D 8456    3742     STY Z56      ;set guard bit to 0 for higher
B88F A261    3743     LDX $61      ;point to smaller
8891 D004    3744     BNE BB897
B893 A000    3745 BB893 LDY $00      ;if second flp accu lower
B895 8470    3746     STY Z70      ;move 0 to guard bit of lower
B897 C9F9    3747 88897 CMP $F9      ;if difference more than 8
8899 30C7    3748     BMI 88862      ;do preshifts
B89B A8      3749     TAY      ;save number of preshifts
889C A570    3750     LDA Z70      ;get guard bit
B89E 5601    3751     LSR Z01,X      ;pad with zero
B8A0 208089  3752     JSR S8980      ;do preshifts
88A3 246F    3753 BB8A3 BIT Z6F      ;if both signs are the same
B8A5 1057    3754     8PL BB8FE      ;add fractions

```

```

3756 ;negate flp accu if borrow, and postshift
3757 ;
B8A7 A061 3758 LDY $61 ;let Y point
B8A9 E069 3759 CPX $69
B8AB F002 3760 BEQ BB8AF
B8AD A069 3761 LDY $69 ;to higher
B8AF 38 3762 BB8AF SEC
B8B0 49FF 3763 EOR $FF ;compute initial borrow
B8B2 6556 3764 ADC Z56 ;from guard bit
B8B4 8570 3765 STA Z70
B8B6 B90400 3766 LDA Z04,Y
B8B9 F504 3767 SBC Z04,X ;compute difference, byte 4
B8B8 8565 3768 STA Z65
B8BD B90300 3769 LDA Z03,Y
B8C0 F503 3770 SBC Z03,X ;byte 3
B8C2 8564 3771 STA Z64
B8C4 B90200 3772 LDA Z02,Y
B8C7 F502 3773 SBC Z02,X ;byte 2
B8C9 8563 3774 STA Z63
B8CB B90100 3775 LDA Z01,Y
B8CE F501 3776 SBC Z01,X ;and byte 1
B8D0 8562 3777 STA Z62
B8D2 B003 3778 JB8D2 BCS BB8D7 ;if borrow
B8D4 2047B9 3779 JSR SB947 ;negate result
B8D7 A000 3780 BB8D7 LDY $00 ;initialize parameters
B8D9 98 3781 TYA
B8DA 18 3782 CLC ;for postshift
B8DB A662 3783 BB8DB LDX Z62 ;if most significant byte 0
B8DD D04A 3784 BNE BB929 ;shift fraction over one byte
B8DF A663 3785 LDX Z63
B8E1 8662 3786 STX Z62
B8E3 A664 3787 LDX Z64
B8E5 8663 3788 STX Z63
B8E7 A665 3789 LDX Z65
B8E9 8664 3790 STX Z64
B8EB A670 3791 LDX Z70
B8ED 8665 3792 STX Z65
B8EF 8470 3793 STY Z70
B8F1 6908 3794 ADC $08 ;correct exponent by 8
B8F3 C920 3795 CMP $20
B8F5 DOE4 3796 BNE BB8DB ;repeat until 4 bytes shifted
B8F7 A900 3797 JB8F7 LDA $00 ;because then result = 0
B8F9 8561 3798 JB8F9 STA Z61
B8FB 8566 3799 JB8FB STA Z66
B8FD 60 3800 RTS

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```

3802 ;add fractions
3803 ;
B8FE 6556 3804 BB8FE ADC Z56      ;compute initial fraction
B900 8570 3805 STA Z70          ;also set guard bit
B902 A565 3806 LDA Z65
B904 656D 3807 ADC Z6D          ;compute sum, byte 4
B906 8565 3808 STA Z65
B908 A564 3809 LDA Z64
B90A 656C 3810 ADC Z6C          ;byte 3
B90C 8564 3811 STA Z64
B90E A563 3812 LDA Z63
B910 656B 3813 ADC Z6B          ;byte 2
B912 8563 3814 STA Z63
B914 A562 3815 LDA Z62
B916 656A 3816 ADC Z6A          ;byte 1
B918 8562 3817 STA Z62
B91A 4C36B9 3818 JMP JB936      ;go adjust for carry outside byte 1
3819 ;
3820 ;postshift
3821 ;
B91D 6901 3822 BB91D ADC $01      ;add 1 to exponent
B91F 0670 3823 ASL Z70          ;shift left 1 bit
B921 2665 3824 ROL Z65          ;over whole fraction
B923 2664 3825 ROL Z64
B925 2663 3826 ROL Z63
B927 2662 3827 ROL Z62
B929 10F2 3828 BB929 BPL BB91D    ;repeat until MSB = 1
B92B 38 3829 SEC                ;subtract correction from exponent
B92C E561 3830 SBC Z61          ;underflow causes zero result
B92E B0C7 3831 BCS JB8F7
B930 49FF 3832 EOR $FF          ;store new exponent
B932 6901 3833 ADC $01          ;carry means overflow in fraction
B934 8561 3834 STA Z61          ;so increment exponent
B936 900E 3835 JB936 BCC BB946    ;unless exponent overflows
B938 E661 3836 JB938 INC Z61    ;and shift right by one bit
B93A F042 3837 BEQ BB97E
B93C 6662 3838 ROR Z62
B93E 6663 3839 ROR Z63
B940 6664 3840 ROR Z64
B942 6665 3841 ROR Z65
B944 6670 3842 ROR Z70          ;including guard bit
B946 60 3843 BB946 RTS

```

```

3845 ;negate flp accu
3846 ;
B947 A566 3847 SB947 LDA Z66
B949 49FF 3848 EOR $FF ;complement sign
B94B 8566 3849 STA Z66
B94D A562 3850 SB94D LDA Z62
B94F 49FF 3851 EOR $FF ;complement fraction byte 4
B951 8562 3852 STA Z62
B953 A563 3853 LDA Z63
B955 49FF 3854 EOR $FF ;byte 3
B957 8563 3855 STA Z63
B959 A564 3856 LDA Z64
B95B 49FF 3857 EOR $FF ;byte 2
B95D 8564 3858 STA Z64
B95F A565 3859 LDA Z65
B961 49FF 3860 EOR $FF ;and byte 1
B963 8565 3861 STA Z65
B965 A570 3862 LDA Z70
B967 49FF 3863 EOR $FF ;and guard bit
B969 8570 3864 STA Z70 ;if guard bit 0
B96B E670 3865 INC Z70
B96D D00E 3866 BNE BB97D ;then increment fraction
3867 ;
3868 ;increment fraction
3869 ;
B96F E665 3870 SB96F INC Z65 ;increment byte 4
B971 D00A 3871 BNE BB97D ;if 0
B973 E664 3872 INC Z64 ;byte 3 also
B975 D006 3873 BNE BB97D ;if 0
B977 E663 3874 INC Z63 ;byte 2 also
B979 D002 3875 BNE BB97D ;if 0
B97B E662 3876 INC Z62 ;byte 1 also
B97D 60 3877 BB97D RTS ;zero here means overflow
3878 ;
B97E A20F 3879 BB97E LDX $0F ;point to OVERFLOW Error
B980 4C37A4 3880 JMP JA437 ;print message

```

```

3882 ;preshift
3883 ;
B983 A225 3884 JB983 LDX $25
B985 B404 3885 BB985 LDY Z04,X ;shift whole fraction
B987 8470 3886 STY Z70 ;right one byte
B989 B403 3887 LDY Z03,X
B98B 9404 3888 STY Z04,X
B98D B402 3889 LDY Z02,X
B98F 9403 3890 STY Z03,X
B991 B401 3891 LDY Z01,X
B993 9402 3892 STY Z02,X ;high order padding
B995 A468 3893 LDY Z68
3997 9401 3894 STY Z01,X
B999 6908 3895 SB999 ADC $08
B99B 3018 3896 BMI BB985
B99D F0E6 3897 BEQ BB985
B99F E908 3898 SBC $08 ;compensate for correction
B9A1 A8 3899 TAY
B9A2 A570 3900 LDA Z70 ;check guard bit
B9A4 B014 3901 BCS BB9BA ;if exponent zero now, stop shifting
B9A6 1601 3902 BB9A6 ASL Z01,X ;else
B9A8 9002 3903 BCC BB9AC
B9AA F601 3904 INC Z01,X
B9AC 7601 3905 BB9AC ROR Z01,X ;shift fraction right one bit
B9AE 7601 3906 ROR Z01,X
B9B0 7602 3907 SB9B0 ROR Z02,X
B9B2 7603 3908 ROR Z03,X
B9B4 7604 3909 ROR Z04,X ;last bit into A
B9B6 6A 3910 ROR A
B9B7 C8 3911 INY
B9B8 DOEC 3912 BNE BB9A6 ;until # of shifts zero
B9EA 18 3913 BB9BA CLC
B9BB 60 3914 RTS

```

```

3916 ;1, also used as default FOR step
B9BC 810000 3917 TB9BC .BY $81,$00,$00,$00,$00
3918 ;polynome table for LOG
B9C1 03     3919 TB9C1 .BY $03
3920 ;0.434255942
B9C2 7F5E56 3921 .BY $7F,$5E,$56,$CB,$79
3922 ;0.576584541
B9C7 80139B 3923 .BY $80,$13,$9B,$0B,$64
3924 ;0.961800759
B9CC 807638 3925 .BY $80,$76,$38,$93,$16
3926 ;2.88539007
B9D1 8238AA 3927 .BY $82,$38,$AA,$3B,$20
3928 ;0.5 * SQR(2)
B9D6 803504 3929 TB9D6 .BY $80,$35,$04,$F3,$34
3930 ;SQR(2)
B9DB 813504 3931 TB9DB .BY $81,$35,$04,$F3,$34
3932 ;-0.5
B9EO 808000 3933 TB9EO .BY $80,$80,$00,$00,$00
3934 ;LOG(2)
B9E5 803172 3935 TB9E5 .BY $80,$31,$72,$17,$F8
3936 ;
3937 ;"LOG" command
3938 ;
B9EA 3939 WB9EA = *
B9EA 202BBC 3940 SB9EA JSR SBC2B ;get sign of flp accu into A
B9ED F002    3941 BEQ BB9F1
B9EF 1003    3942 BPL BB9F4 ;if > 0, OK
B9F1 4C48B2  3943 BB9F1 JMP JB248 ;else ILLEGAL QUANTITY Error
3944 ;
B9F4 A561    3945 BB9F4 LDA Z61 ;get exponent
B9F6 E97F    3946 SBC $7F ;correct for excess of 128
B9F8 48      3947 PHA ;and save result
B9F9 A980    3948 LDA $80
B9FB 8561    3949 STA Z61 ;set exponent
B9FD A9D6    3950 LDA <TB9D6
B9FF A0B9    3951 LDY >TB9D6 ;set AY to point to 0.5 * SQR(2)
BA01 2067B8  3952 JSR SB867 ;add to flp accu
BA04 A9DB    3953 LDA <TB9DB
BA06 A0B9    3954 LDY >TB9DB ;set AY to point to SQR(2)
BA08 200FB8  3955 JSR SBB0F ;divide AY by flp accu
BA0B A9BC    3956 LDA <TB9BC
BA0D A0B9    3957 LDY >TB9BC ;set AY to point to 1
BA0F 2050B8  3958 JSR SB850 ;subtract flp accu from AY
BA12 A9C1    3959 LDA <TB9C1
BA14 A0B9    3960 LDY >TB9C1 ;set AY to polynome table
BA16 2043E0  3961 JSR XE043 ;compute odd polynome
BA19 A9E0    3962 LDA <TB9E0
BA1B A0B9    3963 LDY >TB9E0 ;set AY to point to -0.5
BA1D 2067B8  3964 JSR SB867 ;add to flp accu
BA20 68      3965 PLA ;restore exponent
BA21 207EBD  3966 JSR JBD7E ;add exponent to flp accu
BA24 A9E5    3967 LDA <TB9E5
BA26 A0B9    3968 LDY >TB9E5 ;set AY to LOG(2)
BA28 208CBA  3969 SBA28 JSR SBA8C ;multiply AY times flp accu

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3971 ; "*" operator
3972 ;
BA2B D003 3973 WBA2B BNE BBA30 ;if flp accu = 0, return
BA2D 4C8BBA 3974 JMP JBA8B
3975 ;
BA30 20B7BA 3976 BBA30 JSR SBAB7 ;add exponents
BA33 A900 3977 LDA $00
BA35 8526 3978 STA Z26
BA37 8527 3979 STA Z27
BA39 8528 3980 STA Z28
BA3B 8529 3981 STA Z29
BA3D A570 3982 LDA Z70 ;get guard bit
BA3F 2059BA 3983 JSR SBA59 ;* second flp accu added to flp accu ext.
BA42 A565 3984 LDA Z65
BA44 2059BA 3985 JSR SBA59 ;same for byte 4
BA47 A564 3986 LDA Z64
BA49 2059BA 3987 JSR SBA59 ;same for byte 3
BA4C A563 3988 LDA Z63
BA4E 2059BA 3989 JSR SBA59 ;and byte 2
BA51 A562 3990 LDA Z62
BA53 205EBA 3991 JSR SBA5E ;and byte 1
BA56 4C8FB8 3992 JMP JBB8F ;post-normalize and return
3993 ;
3994 ;add second flp accu * A to flp extension
3995 ;
BA59 D003 3996 SBA59 BNE SBA5E ;if a zero
BA5B 4C83B9 3997 JMP JB983 ;perform pre-shift
3998 ;
BA5E 4A 3999 SBA5E LSR A ;shift LSB of A into carry
BA5F 0980 4000 ORA $80 ;set to $80 only after 8 shifts
BA61 A8 4001 BBA61 TAY ;save A
BA62 9019 4002 BCC BBA7D ;if low bit set
BA64 18 4003 CLC
BA65 A529 4004 LDA Z29
BA67 656D 4005 ADC Z6D ;add second flp fraction
BA69 8529 4006 STA Z29 ;to flp extension
BA6B A528 4007 LDA Z28
BA6D 656C 4008 ADC Z6C
BA6F 8528 4009 STA Z28 ;also byte 2
BA71 A527 4010 LDA Z27
BA73 656B 4011 ADC Z6B
BA75 8527 4012 STA Z27 ;and byte 3
BA77 A526 4013 LDA Z26
BA79 656A 4014 ADC Z6A
BA7B 8526 4015 STA Z26 ;and byte 4
BA7D 6626 4016 BBA7D ROR Z26 ;shift flp extension right 1 bit
BA7F 6627 4017 ROR Z27
BA81 6628 4018 ROR Z28
BA83 6629 4019 ROR Z29
BA85 6670 4020 ROR Z70 ;including guard bit
BA87 98 4021 TYA ;restore A
BA88 4A 4022 LSR A ;get low bit of A into carry
BA89 D0D6 4023 BNE BBA61 ;repeat until zero
BA8B 60 4024 JBA8B RTS

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```

4026 ;move flp # indexed by AY into second flp accu
4027 ;
BA8C 8522 4028 SBA8C STA Z22      ;save AY index
BA8E 8423 4029 STY Z23
BA90 A004 4030 LDY $04
BA92 B122 4031 LDA (Z22),Y   ;move byte 4 of fraction
BA94 856D 4032 STA Z6D
BA96 88   4033 DEY
BA97 B122 4034 LDA (Z22),Y
BA99 856C 4035 STA Z6C      ;byte 3
BA9B 88   4036 DEY
BA9C B122 4037 LDA (Z22),Y
BA9E 856B 4038 STA Z6B      ;byte 2
BAA0 88   4039 DEY
BAA1 B122 4040 LDA (Z22),Y
BAA3 856E 4041 STA Z6E      ;and byte 1
BAA5 4566 4042 EOR Z66      ;into sign
BAA7 856F 4043 STA Z6F      ;also Exclusive OR with sign of flp accu
BAA9 A56E 4044 LDA Z6E
BAAE 0980 4045 ORA $80
BAAD 856A 4046 STA Z6A      ;byte 1 always has bit 7 set
BAAF 88   4047 DEY
BAB0 B122 4048 LDA (Z22),Y
BAB2 8569 4049 STA Z69      ;save exponent
BAB4 A561 4050 LDA Z61      ;show exponent of flp accu in A, Z and N
BAB6 60   4051 RTS

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```

4053 ;add exponents
4054 ;
BAB7 A569 4055 SBAB7 LDA Z69      ;get exp. of 2nd flp accu (left operand)
BAB9 F0F9 4056 BEQ BBADA          ;if zero, set zero result
BAB8 18    4057 CLC
BABC 6561 4058 ADC Z61          ;add to exponent of flp accu
BABE 9004 4059 BCC BBAC4          ;if carry set
BAC0 301D 4060 BMI BBADF          ;and negative, true overflow
BAC2 18    4061 CLC          ;else correct for excess 128
BAC3 2C    4062 .BY $2C          ;skip next instruction
BAC4 1014 4063 BBAC4 BPL BBADA  ;if C = 1 and positive, real underflow
BAC6 6980 4064 ADC $80          ;else correct for excess 128
BAC8 8561 4065 STA Z61          ;store resulting exponent
BACA D003 4066 BNE BBACF          ;if zero
BACC 4CFBB8 4067 JMP JB8FB          ;set sign positive
4068 ;
BACF A56F 4069 BBACF LDA Z6F      ;Exclusive OR of signs
BAD1 8566 4070 STA Z66          ;is sign of result
BAD3 60    4071 RTS
4072 ;
BAD4 A566 4073 LDA Z66          ;get sign of flp accu
BAD6 49FF 4074 EOR $FF
BAD8 3005 4075 BMI BBADF          ;if positive, overflow
BADA 68    4076 BBADA PLA          ;remove own return address
BADB 68    4077 PLA
BADC 4CF7Bd 4078 JMP JB8F7          ;and set result zero
4079 ;
BADF 4C7EB9 4080 BBADF JMP BB97E          ;OVERFLOW Error
4081 ;
4082 ;multiply flp accu by 10
4083 ;
BAE2 200CBC 4084 SBAE2 JSR SBCOC  ;move rounded flp into second flp accu
BAE5 AA    4085 TAX          ;get exponent
BAE6 F010 4086 BEQ BBAF8          ;if flp accu is zero, return
BAE8 18    4087 CLC
BAE9 6902 4088 ADC $02          ;exponent of second flp + 2 (# * 4)
BAEB BOF2 4089 BCS BBADF          ;exit if overflow
BAED A200 4090 SBAED LDX $00
BAEF 866F 4091 STX Z6F          ;set signs same
BAF1 2077B8 4092 JSR SB877          ;add second flp accu to flp (# * 5)
EAF4 E661 4093 INC Z61          ;add 1 to exponent (# * 10)
BAF6 FOE7 4094 BEQ BBADF          ;exit if overflow
BAF8 60    4095 BBAF8 RTS
4096 ;
4097 ;flp constant 10 for division
BAF9 8420C0 4098 TBAF9 .BY $84,$20,$00,$00,$00
4099 ;
4100 ;divide flp accu by 10
4101 ;
BAFE 200CBC 4102 SBAFE JSR SBCOC  ;move rounded flp accu to 2nd flp accu
BB01 A9F9 4103 LDA <TBAF9
BB03 A0BA 4104 LDY >TBAF9          ;set AY to flp value 10
BB05 A200 4105 LDX $00
BB07 866F 4106 STX Z6F          ;set signs the same
BB09 20A2BB 4107 JSR SBBA2          ;load flp accu from AY
BBC0 4C12BB 4108 JMP JBB12          ;perform division

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        4110 ;divide number (indexed by AY) by flp accu
        4111 ;
BBOF 208CBA 4112 SBB0F JSR SBA8C      ;fetch # indexed by AY into 2nd flp accu
        4113 ;
        4114 ;"/" operator
        4115 ;
BB12          4116 WBB12 =  *
BB12 F076    4117 JBB12 BEQ BBB8A      ;if flp accu = 0, DIVISION BY ZERO Error
BB14 201BBC   4118 JSR SBC1B        ;round flp accu according to guard bit
BB17 A900    4119 LDA $00
BB19 38      4120 SEC
BB1A E561    4121 SBC Z61        ;compute 2's complement of exponent
BB1C 8561    4122 STA Z61
BB1E 2087BA   4123 JSR SBAB7      ;add exponents
BB21 E661    4124 INC Z61        ;correct exponent
BB23 FOBA    4125 BEQ BBBADF     ;exit if overflow
BB25 A2FC    4126 LDX $FC        ;set initial index into flp extension
BB27 A901    4127 LDA $01        ;assure 8 loops per byte
BB29 A46A    4128 BBB29 LDV Z6A
BB2B C462    4129 CPY Z62        ;compare fractions, byte 1
BB2D D010    4130 BNE BBB3F
BB2F A46B    4131 LDY Z6B
BB31 C463    4132 CPY Z63
BB33 D00A    4133 BNE BBB3F
BB35 A46C    4134 LDV Z6C
BB37 C464    4135 CPY Z64        ;byte 2
BB39 D004    4136 BNE BBB3F
BB3B A46D    4137 LDY Z6D
BB3D C465    4138 CPY Z65        ;byte 3
BB3F OB      4139 BBB3F PHP        ;save result of comparison
BB40 2A      4140 ROL A        ;shift result into A
BB41 9009   4141 BCC BBB4C     ;after 8 shifts
BB43 E8      4142 INX
BB44 9529    4143 STA Z29,X      ;save result into flp extension
BB46 F032    4144 BEQ BBB7A      ;after byte 4, do guard byte
BB48 1034    4145 BPL BBB7E     ;after guard byte, exit
BB4A A901    4146 LDA $01        ;again, 8 iterations per byte
BB4C 28      4147 BBB4C PLP        ;restore result of comparison
BB4D B00E    4148 BCS BBB5D      ;if dividend larger, subtract
BB4F 066D    4149 JBB4F ASL Z6D
BB51 266C    4150 ROL Z6C        ;shift dividend left 1 bit
BB53 266B    4151 ROL Z6B
BB55 266A    4152 ROL Z6A
BB57 BOE6    4153 BCS BBB3F      ;if C = 1 comparison result will be 1
BB59 30CE    4154 BMI BBB29      ;if C = 0 and MSB = 1, compare
BB5B 10E2    4155 BPL BBB3F      ;if C = 0 and MSB = 0, comp. result = 0
BB5D A8      4156 BBB5D TAY        ;if dividend larger
BB5E A56D    4157 LDA Z6D
BB60 E565    4158 SBC Z65        ;subtract divisor
BB62 856D    4159 STA Z6D
BB64 A56C    4160 LDA Z6C
BB66 E564    4161 SBC Z64        ;byte 2
BB68 856C    4162 STA Z6C
BB6A A56B    4163 LDA Z6B
BB6C E563    4164 SBC Z63        ;byte 3
BB6E 856B    4165 STA Z6B
BB70 A56A    4166 LDA Z6A
BB72 E562    4167 SBC Z62        ;byte 4
BB74 856A    4168 STA Z6A
BB76 98      4169 TYA

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BB77 4C4FBB 4170      JMP JBB4F    ;repeat
        4171 ;
BB7A A940 4172 BBB7A LDA $40      ;two more iterations for guard bit
BB7C DOCE 4173         BNE BBB4C
BB7E OA   4174 BBB7E ASL A      ;after guard byte computation,
BB7F OA   4175         ASL A      ;shift result left 6 bits
BB80 OA   4176         ASL A
BB81 OA   4177         ASL A
BB82 OA   4178         ASL A
BB83 OA   4179         ASL A
BB84 8570 4180 STA Z70      ;set new guard bit
BB86 28   4181 PLP          ;remove result of last comparison
BB87 4C8FBB 4182 JMP JBB8F    ;and save result
        4183 ;
BB8A A214 4184 BBB8A LDX $14    ;point to DIVISION BY ZERO Error
BB8C 4C37A4 4185 JMP JA437    ;print error
        4186 ;
BB8F A526 4187 JBB8F LDA Z26    ;move flp accu extension
BB91 8562 4188 STA Z62      ;into flp fraction
BB93 A527 4189 LDA Z27
BB95 8563 4190 STA Z63      ;byte 2
BB97 A528 4191 LDA Z28
BB99 8564 4192 STA Z64      ;byte 3
BB9B A529 4193 LDA Z29
BB9D 8565 4194 STA Z65      ;byte 4
BB9F 4CD7B8 4195 JMP BB8D7    ;do post-normalization
        4196 ;
        4197 ;load flp accu with constant indexed by AY
        4198 ;
BBA2 8522 4199 SBBA2 STA Z22
BBA4 8423 4200 STY Z23      ;save AY
BBA6 A004 4201 LDY $04
BBA8 B122 4202 LDA (Z22),Y    ;load byte + 4
BBAA 8565 4203 STA Z65      ;into flp accu + 4
BBAC 88   4204 DEY
BBAD B122 4205 LDA (Z22),Y    ;byte + 3
BBAF 8564 4206 STA Z64
BBB1 88   4207 DEY
BBB2 B122 4208 LDA (Z22),Y    ;byte + 2
BBB4 8563 4209 STA Z63
BBB6 88   4210 DEY
BBB7 B122 4211 LDA (Z22),Y    ;byte + 1
BBB9 8566 4212 STA Z66      ;into sign byte
BBBB 0980 4213 ORA $80      ;and with bit 7 set
BBBD 8562 4214 STA Z62      ;into flp accu + 1
BBBF 88   4215 DEY
BBC0 B122 4216 LDA (Z22),Y    ;byte + 0
BBC2 8561 4217 STA Z61      ;into exponent of flp accu
BBC4 8470 4218 STY Z70      ;clear guard bit
BBC6 60   4219 RTS

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```

4221 ;store flp accu at Z5C-Z60
4222 ;
BBC7 A25C 4223      LDX <Z5C      ;initialize low byte of pointer
BBC9 2C     4224      .BY $2C      ;skip next instruction
4225 ;
4226 ;store flp accu at Z57-Z5B
4227 ;
BBCA A257 4228      LDX <Z57      ;initial j:=e low byte of pointer
BBCC A000 4229      LDY >Z57      ;initialize high byte of pointer
BBCF F004 4230      BEQ SBBD4    ;JMP
4231 ;
4232 ;store flp accu into area indexed by Z49/Z4A
4233 ;
BBD0 A649 4234 JBBDO LDX Z49      ;set area pointer in XY
BBD2 A44A 4235      LDY Z4A
4236 ;
4237 ;store flp accu in area indexed by XY
4238 ;
BBD4 201BBC 4239 SBBD4 JSR SBC1B   ;round flp accu
BBD7 8622 4240      STX Z22      ;store XY in temporary pointer
BBD9 8423 4241      STY Z23
BBDB A004 4242      LDY $04
BBDD A565 4243      LDA Z65      ;move byte 4 of fraction
BBDF 9122 4244      STA (Z22),Y
BBE1 88    4245      DEY
BBE2 A564 4246      LDA Z64
BBE4 9122 4247      STA (Z22),Y  ;byte 3
BBE6 88    4248      DEY
BBE7 A563 4249      LDA Z63
BBE9 9122 4250      STA (Z22),Y  ;byte 2
BBEB 88    4251      DEY
BBEC A566 4252      LDA Z66      ;combine sign
BBEE 097F 4253      ORA $7F
BBFO 2562 4254      AND Z62      ;and byte 1
BBF2 9122 4255      STA (Z22),Y  ;into byte 1 of area
BBF4 88    4256      DEY
BBF5 A561 4257      LDA Z61      ;move exponent
BBF7 9122 4258      STA (Z22),Y
BBF9 8470 4259      STY Z70      ;clear guard bit
BBFB 60    4260      RTS
4261 ;
4262 ;move second flp accu into first flp accu
4263 ;
BBFC A56E 4264 SBBFC LDA Z6E      ;move sign
BBFE 8566 4265 SBBFE STA Z66
BC00 A205 4266      LDX $05      ;loop counter
BC02 B568 4267 BBC02 LDA Z68,X   ;move 5 bytes
BC04 9560 4268      STA Z60,X
BC06 CA    4269      DEX
BC07 D0F9 4270      BNE BBC02
BC09 8670 4271      STX Z70      ;set product of signs to "+"
BC0B 60    4272      RTS

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4274 ;move rounded flp accu into second flp accu
4275 ;
BC0C 201BBC 4276 SBCOC JSR SBC1B      ;round flp accu
BC0F A206   4277   LDX $06           ;set # bytes to move
BC11 B560   4278 BBC11 LDA Z60,X     ;move 6 bytes
BC13 9568   4279   STA Z68,X
BC15 CA     4280   DEX
BC16 D0F9   4281   BNE BBC11
BC18 8670   4282   STX Z70        ;store zero into guard bit
BC1A 60     4283 BBC1A RTS
4284 ;
4285 ;round flp accu according to guard bit
4286 ;
BC1B A561   4287 SBC1B LDA Z61      ;if flp accu = 0
BC1D F0FB   4288   BEQ BBC1A      ;leave it at 0
BC1F 0670   4289   ASL Z70        ;if guard bit not set
BC21 90F7   4290   BCC BBC1A      ;status quo
BC23 206FB9 4291 SBC23 JSR SB96F    ;increment fraction
BC26 D0F2   4292   BNE BBC1A      ;if no overflow, leave it
BC28 4C38B9 4293   JMP JB938     ;else shift fraction right 1 bit
4294 ;
4295 ;get sign of flp accu in A
4296 ;
BC2B A561   4297 SBC2B LDA Z61      ;if exponent zero
BC2D F009   4298   BEQ BBC38     ;sign = 0
BC2F A566   4299 BBC2F LDA Z66      ;move sign bit
BC31 2A     4300 JBC31 ROL A      ;into C bit
BC32 A9FF   4301   LDA $FF        ;if C = 1, sign = FF
BC34 B002   4302   BCS BBC38
BC36 A901   4303   LDA $01        ;if C = 0, sign = 01
BC38 60     4304 BBC38 RTS
4305 ;
4306 ;"SGN" command
4307 ;
BC39 202BBC 4308 WBC39 JSR SBC2B    ;get SGN of flp accu into A
4309 ;
4310 ;move signed number from A into flp accu
4311 ;
BC3C 8562   4312 JBC3C STA Z62      ;store # in most significant byte
BC3E A900   4313   LDA $00
BC40 8563   4314   STA Z63        ;and 0 into byte 2
BC42 A288   4315   LDX $88        ;load exponent
BC44 A562   4316 JBC44 LDA Z62
BC46 49FF   4317   EOR $FF        ;complement sign
BC48 2A     4318   ROL A        ;and move into C flag
BC49 A900   4319 SBC49 LDA $00
BC4B 8565   4320   STA Z65        ;clear byte 3
BC4D 8564   4321   STA Z64        ;and byte 4
BC4F 8661   4322 JBC4F STX Z61      ;store exponent
BC51 8570   4323   STA Z70        ;move sign to guard bit
BC53 8566   4324   STA Z66        ;and to sign bit
BC55 4CD2B8 4325   JMP JB8D2     ;negate flp accu if borrow and post-shift

```

```

4327 ;"ABS" command
4328 ;
BC58 4666 4329 WBC58 LSR Z66      ;set sign of flp accu positive
BC5A 60    4330     RTS
4331 ;
4332 ;compare flp accu to flp # indexed by AY
4333 ;
BC5B 8524 4334 SBC5B STA Z24      ;save index to variable
BC5D 8425 4335 SBC5D STY Z25
BC5F A000 4336 LDY $00
BC61 B124 4337 LDA (Z24),Y ;get exponent of variable
BC63 C8   4338 INY
BC64 AA   4339 TAX
BC65 F0C4 4340 BEQ SBC2B ;if zero, get sign of flp accu
BC67 B124 4341 LDA (Z24),Y ;get byte 1 of fraction
BC69 4566 4342 EOR Z66 ;if different from sign of flp accu
BC6B 30C2 4343 BMI BBC2F ;get sign of flp accu
BC6D E461 4344 CPX Z61 ;compare exponents
BC6F D021 4345 BNE BBC92 ;if not equal, set sign according to C
BC71 B124 4346 LDA (Z24),Y ;get byte 1
BC73 0980 4347 ORA $80 ;compare to byte 1 of flp accu
BC75 C562 4348 CMP Z62 ;if not equal, set sign according to C
BC77 D019 4349 BNE BBC92
BC79 C8   4350 INY
BC7A B124 4351 LDA (Z24),Y ;get byte 2
BC7C C563 4352 CMP Z63 ;compare to byte 2 of flp accu
BC7E D012 4353 BNE BBC92 ;if not equal, set sign according to C
BC80 C8   4354 INY
BC81 B124 4355 LDA (Z24),Y ;get byte 3
BC83 C564 4356 CMP Z64 ;compare to byte 3 of flp accu
BC85 D00B 4357 BNE BBC92 ;if not equal, set sign according to C
BC87 C8   4358 INY
BC88 A97F 4359 LDA $7F ;set borrow
BC8A C570 4360 CMP Z70 ;according to guard bit
BC8C B124 4361 LDA (Z24),Y
BC8E E565 4362 SBC Z65 ;compute difference between bytes 4
BC90 F028 4363 BEQ BBCBA ;if equal, return with A = 0
BC92 A566 4364 BBC92 LDA Z66 ;else compute sign according to C
BC94 9002 4365 BCC BBC98
BC96 49FF 4366 EOR $FF
BC98 4C31BC 4367 BBC98 JMP JBC31 ;and set A accordingly

```

```

4369 ;convert flp accu to a 4 byte signed integer
4370 ;
BC9B A561 4371 SBC9B LDA Z61      ;get exponent
BC9D F04A 4372 BEQ BBCE9        ;if zero fill fraction with zeros
BC9F 38    4373 SEC
BCA0 E9A0  4374 SBC $AO        ;calculate exponent - 32
BCA2 2466  4375 BIT Z66        ;if result negative
BCA4 1009  4376 BPL BBCAF
BCA6 AA    4377 TAX          ;save A
BCA7 A9FF  4378 LDA $FF        ;set padding to ones
BCA9 8568  4379 STA Z68
BCAB 204DB9 4380 JSR SB94D    ;negate flp fraction
BCAE 8A    4381 TXA          ;restore A
BCAF A261  4382 BBCAF LDX $61    ;if < 8 places to be shifted
BCB1 C9F9  4383 CMP $F9
BCB3 1006  4384 BPL BBCBB
BCB5 2099B9 4385 JSR SB999    ;do shift
BCB8 8468  4386 STY Z68        ;and reset padding
BCBA 60    4387 BBCBA RTS
4388 ;
BCBB A8    4389 BBCBB TAY        ;if > = 8 places to be shifted
BCBC A566  4390 LDA Z66
BCBE 2980  4391 AND $80
BCC0 4662  4392 LSR Z62        ;set parameters
BCC2 0562  4393 ORA Z62
BCC4 8562  4394 STA Z62        ;and MSB
BCC6 20B0B9 4395 JSR SB980    ;to do byte shifts first
BCC9 8468  4396 STY Z68        ;and then reset padding
BCCB 60    4397 RTS
4398 ;
4399 ;"INT" command
4400 ;
BCCC 4401 WBCCC = *
BCCC A561  4402 SBCCC LDA Z61    ;get exponent
BCCE C9A0  4403 CMP $AO        ;if > = 32
BCDO B020  4404 BCS BBCF2
BCD2 209BBC 4405 JSR SBC9B    ;then no conversion necessary
BCD5 8470  4406 STY Z70        ;convert flp accu to 4 byte integer
BCD7 A566  4407 LDA Z66        ;clear guard bit
BCD9 8466  4408 STY Z66        ;get sign
BCDB 4980  4409 EOR $80        ;set sign positive
BCDD 2A    4410 ROL A          ;invert sign
BCDE A9A0  4411 LDA $AO        ;and move into carry
BCEO 8561  4412 STA Z61        ;set exponent to 32
BCE2 A565  4413 LDA Z65        ;move least significant bit
BCE4 8507  4414 STA Z07        ;into even/odd switch
BCE6 4CD2B8 4415 JMP JB8D2    ;negate flp accu if borrow
4416 ;
4417 ;clear flp accu
4418 ;
BCE9 8562  4419 BBCE9 STA Z62    ;move A into every byte of fraction
BCEB 8563  4420 STA Z63
BCED 8564  4421 STA Z64
BCEF 8565  4422 STA Z65
BCF1 A8    4423 TAY
BCF2 60    4424 BBCF2 RTS

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        4426 ;convert string to flp # in flp accu
4427 ;
BCF3 A000 4428 SBCF3 LDY $00
BCF5 A20A 4429 LDX $0A      ;loop counter, 11 bytes to be cleared
BCF7 945D 4430 BBCF7 STY Z5D,X ;clear flp accu and 5 more
BCF9 CA    4431 DEX
BCFA 10FB 4432 BPL BBCF7
BCFC 900F 4433 BCC BBDOD   ;if first character not numeric
BCFE C92D 4434 CMP '-'     ;check for minus
BD00 D004 4435 BNE BBD06   ;if so,
BD02 8667 4436 STX Z67    ;set flag for negative #
BD04 F004 4437 BEQ BBD0A
BD06 C92B 4438 BBD06 CMP '+' ;check for positive number
BD08 D005 4439 BNE BBD0F   ;if not, go try others
BD0A 207300 4440 BBD0A JSR X0073
BD0D 905B 4441 BBDOD BCC BBD6A ;get next character
BD0F C92E 4442 BBD0F CMP '.'
BD11 F02E 4443 BEQ BBD41   ;if decimal point,
BD13 C945 4444 CMP 'E'     ;set flag
BD15 D030 4445 BNE BBD47   ;if exponent character
BD17 207300 4446 JSR X0073
BD1A 9017 4447 BCC BBD33   ;get next character
BD1C C9AB 4448 CMP $AB     ;if numeric, gather exponent value
BD1E F00E 4449 BEQ BBD2E   ;if code for "-"
BD20 C92D 4450 CMP '-'     ;or "-" itself
BD22 F00A 4451 BEQ BBD2E   ;set flag
BD24 C9AA 4452 CMP $AA     ;if code for "+"
BD26 F008 4453 BEQ BBD30
BD28 C92B 4454 CMP '+'     ;or "+" itself
BD2A F004 4455 BEQ BBD30   ;skip
BD2C D007 4456 BNE BBD35   ;else combine fraction & exponent
BD2E 6660 4457 BBD2E ROR Z60 ;set flag for negative exponent
BD30 207300 4458 BBD30 JSR X0073
BD33 905C 4459 BBD33 BCC BBD91
BD35 2460 4460 BBD35 BIT Z60 ;at end of exponent
BD37 100E 4461 BPL BBD47   ;if sign of exponent negative
BD39 A900 4462 LDA $00
BD3B 38   4463 SEC
BD3C E55E 4464 SBC Z5E    ;get two's complement of exponent
BD3E 4C49BD 4465 JMP JBD49 ;combine
4466 ;
BD41 665F 4467 BBD41 ROR Z5F ;set code for "." found
BD43 245F 4468 BIT Z5F
BD45 50C3 4469 BVC BBD0A   ;if already set, this is end of number
BD47 A55E 4470 BBD47 LDA Z5E ;get exponent, base 10
BD49 38   4471 JBD49 SEC
BD4A E55D 4472 SBC Z5D    ;minus # of digits after "."
BD4C 855E 4473 STA Z5E    ;save
BD4E F012 4474 BEQ BBD62   ;if zero, no adjustment
BD50 1009 4475 BPL BBD5B   ;if positive, multiply by 10
BD52 20FEBA 4476 BBD52 JSR SBAE2 ;if negative, divide flp accu by 10
BD55 E65E 4477 INC Z5E    ;increment exponent, base 10
BD57 D0F9 4478 BNE BBD52   ;and repeat if not zero
BD59 F007 4479 BEQ BBD62
BD5B 20E2BA 4480 BBD5B JSR SBAE2 ;if positive, multiply flp accu by 10
BD5E C65B 4481 DEC Z5E    ;decrement exponent, base 10
BD60 D0F9 4482 BNE BBD5B   ;and repeat if not zero
BD62 A567 4483 BBD62 LDA Z67 ;get sign of flp #
BD64 3001 4484 BMI BBD67   ;if positive,
BD66 60   4485 RTS ;return

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4486 ;
BD67 4CB4BF 4487 BBD67 JMP JFBF4        ;else apply monadic "-"
4488 ;
BD6A 48    4489 BBD6A PHA               ;save numeric digit
BD6B 245F  4490     BIT Z5F             ;if "." found
BD6D 1002  4491     BPL BBD71          ;increment # of digits after "."
BD6F E65D  4492     INC Z5D             ;multiply flp accu by 10
BD71 20E2BA 4493 BBD71 JSR SBAE2       ;add signed integer from A to flp accu
BD74 68    4494     PLA                ;restore numeric digit
BD75 38    4495     SEC                ;convert from ASCII to binary
BD76 E930  4496     SBC ^0              ;add signed integer from A to flp accu
BD78 207EBD 4497 JSR JBD7E           ;repeat for next character
BD7B 4C0ABD 4498 JMP BBDOA            ;add signed integer from A to flp accu
4499 ;
4500 ;add signed integer from A to flp accu
4501 ;
BD7E 48    4502 JBD7E PHA               ;save integer
BD7F 200CBC 4503 JSR SBCOC            ;move rounded flp accu to 2nd flp accu
BD82 68    4504     PLA                ;restore integer
BD83 203CBC 4505 JSR JBC3C            ;get signed # from A into flp accu
BD86 A56E  4506     LDA Z6E             ;compute Exclusive OR of signs
BD88 4566  4507     EOR Z66             ;let Z and N reflect exponent
BD8A 856F  4508     STA Z6F             ;apply diadic operator "+"
BD8C A661  4509     LDX Z61             ;get exponent of number from a string
BD8E 4C6A88 4510 JMP JB86A            ;let Z and N reflect exponent
4511 ;
4512 ;get exponent gathered so far
4513 ;
BD91 A55E  4514 BBD91 LDA Z5E            ;and sign of exponent is positive
BD93 C90A  4515 CMP $0A               ;if => 10
BD95 9009  4516 BCC BBDAO             ;then overflow
BD97 A964  4517 LDA $64               ;print error
BD99 2460  4518 BIT Z60
BD9B 3011  4519 BMI BBDAE
BD9D 4C7EB9 4520 JMP BB97E
4521 ;
BDA0 0A    4522 BBDAO ASL A            ;exponent * 2
BDA1 0A    4523 ASL A               ;exponent * 4
BDA2 18    4524 CLC
BDA3 655E  4525 ADC Z5E             ;exponent * 5
BDA5 0A    4526 ASL A               ;exponent * 10
BDA6 18    4527 CLC
BDA7 A000  4528 LDY $00
BDA9 717A  4529 ADC (Z7A),Y         ;add current character
BDAB 38    4530 SEC
BDAC E930  4531 SBC ^0              ;convert from ASCII to binary
BDAE 855E  4532 BBDAE STA Z5E            ;save exponent
BDB0 4C30BD 4533 JMP BBD30            ;repeat for next character

```

```

        4535 ;constants for flp to string conversion
        4536 ;
        4537 ;999999.9
BDB3 9B3EBC 4538 TBDB3 .BY $9B,$3E,$BC,$1F,$FD
        4539 ;999999999
BDB8 9E6E6B 4540 TBDB8 .BY $9E,$6E,$6B,$27,$FD
        4541 ;1000000000
BDBD 9E6E6B 4542 TBDBD .BY $9E,$6E,$6B,$28,$00
        4543 ;
        4544 ;print IN followed by statement #
        4545 ;
BDC2 A971 4546 SBDC2 LDA <TA371 ;set AY to IN message
BDC4 A0A3 4547 LDY >TA371
BDC6 20DABD 4548 JSR SBDDA ;print message
BDC9 A53A 4549 LDA Z3A ;get current statement # into AX
BDCB A639 4550 LDX Z39
        4551 ;
        4552 ;print # from AX
        4553 ;
BDCD 8562 4554 SBDCD STA Z62 ;move AX into flp accu
BDCF 8663 4555 STX Z63
BDD1 A290 4556 LDX $90 ;set exponent to 16
BDD3 38 4557 SEC
BDD4 2049BC 4558 JSR SBC49 ;pad out flp accu
BDD7 20DFBD 4559 JSR SBDDF ;convert flp accu to string
BDDA 4C1EAB 4560 SBDDA JMP SAB1E ;and go print string
        4561 ;
        4562 ;convert # in flp accu to string
        4563 ;
BDDD A001 4564 SBDDD LDY $01 ;initial output index
BDDF A920 4565 SBDDF LDA $20 ;set first character to a space
BDE1 2466 4566 8IT Z66 ;but if sign negative
BDE3 1002 4567 BPL BBDE7
BDE5 A92D 4568 LDA '-' ;set first character to "-"
BDE7 99FF00 4569 BBDE7 STA X0100-1,Y ;store sign into output area
BDEA 8566 4570 STA Z66 ;set sign positive
BDEC 8471 4571 STY Z71 ;save output index
BDEE C8 4572INY
BDEF A930 4573 LDA '0 ;assume D
8DF1 A661 4574 LDX Z61 ;if exponent 0
BDF3 D003 4575 BNE BBDF8
BDF5 4C04BF 4576 JMP JBF04 ;output 0 and end string
        4577 ;
BDF8 A900 4578 BBDF8 LDA $00 ;clear exponent, base 10
B DFA E080 4579 CPX $80
BDFC F002 4580 BEQ BBEOD ;if exponent, base 2, = 0
BDFE B009 4581 BCS BBE09 ;or < 0
BED0 A9BD 4582 BBE00 LDA <TBDBD ;set AY to point to 1000D0000D
BE02 A0BD 4583 LDY >TBDBD
BE04 2028BA 4584 JSR SBA28 ;multiply by flp accu
BE07 A9F7 4585 LDA $F7 ;set exponent base 10 to -9
BE09 855D 4586 BBE09 STA Z5D ;save exponent base 10
BEOB A9B8 4587 BBE0B LDA <TBDB8
BE0D A0BD 4588 LDY >TBDB8 ;set AY to index 999999999
8EOF 2058BC 4589 JSR SBC5B ;compare flp accu to AY
8E12 FO1E 4590 BEQ BBE32 ;if equal, no need to adjust exponent
8E14 1012 4591 8PL 88E28 ;if flp accu >, adjust accordingly
BE16 A9B3 4592 88E16 LDA <TBDB3 ;if flp accu <
BE18 A08D 4593 LDY >TBDB3 ;set AY to point to 99999.9
8E1A 20588C 4594 JSR S8C58 ;and compare flp accu to # indexed by AY

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```

BE1D F002 4595 BEQ BBE21
BE1F 100E 4596 BPL BBE2F
BE21 20E2BA 4597 BBE21 JSR SBAE2
BE24 C65D 4598 DEC Z5D
BE26 DOEE 4599 BNE BBE16
BE28 20FEBA 4600 BBE28 JSR SBAFE
BE2B E65D 4601 INC Z5D
BE2D DODC 4602 BNE BBE0B
BE2F 2049B8 4603 BBE2F JSR SB849
BE32 209BBC 4604 BBE32 JSR SBC9B
BE35 A201 4605 LDX $01
BE37 A55D 4606 LDA Z5D
BE39 18 4607 CLC
BE3A 690A 4608 ADC $0A
BE3C 3009 4609 BMI BBE47
BE3E C908 4610 CMP $0B
BE40 B006 4611 BCS BBE48
BE42 69FF 4612 ADC $FF
BE44 AA 4613 TAX
BE45 A902 4614 LDA $02
BE47 38 4615 BBE47 SEC
BE48 E902 4616 BBE48 SBC $02
BE4A 855E 4617 STA Z5E
BE4C 865D 4618 STX Z5D
BE4E 8A 4619 TXA
BE4F F002 4620 BEQ BBE53
BE51 1013 4621 BPL BBE66
BE53 A471 4622 BBE53 LDY Z71
BE55 A92E 4623 LDA
BE57 C8 4624 INY
BE58 99FF00 4625 STA X0100-1,Y ;store it
BE5B 8A 4626 TXA ;if position of decimal point < 0
BE5C F006 4627 BEQ BBE64
BE5E A930 4628 LDA `0 ;set a 0
BE60 C8 4629 INY
BE61 99FF00 4630 STA X0100-1,Y ;and store it
BE64 8471 4631 BBE64 STY Z71 ;save output index
BE66 A000 4632 BBE66 LDY $00 ;set initial table index
BE68 A280 4633 SBE68 LDX $80 ;initial table phase negative
BE6A A565 4634 BBE6A LDA Z65 ;add table entry
BE6C 18 4635 CLC
BE6D 7919BF 4636 ADC TBF16+3,Y ;to fraction, byte 4
BE70 8565 4637 STA Z65
BE72 A564 4638 LDA Z64
BE74 7918BF 4639 ADC TBF16+2,Y ;byte 3
BE77 8564 4640 STA Z64
BE79 A563 4641 LDA Z63
BE7B 7917BF 4642 ADC TBF16+1,Y ;byte 2
BE7E 8563 4643 STA Z63
BE80 A562 4644 LDA Z62
BE82 7916BF 4645 ADC TBF16,Y ;byte 1
BE85 8562 4646 STA Z62
BE87 E8 4647 INX ;increment digit
BE88 B004 4648 BCS BBE8E
BE8A 10DE 4649 BPL BBE6A ;if no overflow and positive, repeat
BE8C 3002 4650 BMI BBE90
BE8E 30DA 4651 BBE8E BMI BBE6A ;if overflow and negative phase, repeat
BE90 8A 4652 BBE90 TXA ;if positive phase
BE91 9004 4653 BCC BBE97
BE93 49FF 4654 EOR $FF ;get 10 - digit

```

```

BE95 690A 4655 ADC $0A
BE97 692F 4656 BBE97 ADC $2F ;convert to ASCII
BE99 C8 4657 INY
BE9A C8 4658 INY
BE9B C8 4659 INY
BE9C C8 4660 INY ;point to next table entry
BE9D 8447 4661 STY Z47 ;save table index
BE9F A471 4662 LDY 271 ;get output index
BEA1 C8 4663 INY
BEA2 AA 4664 TAX ;save digit
BEA3 297F 4665 AND $7F ;remove phase bit
BEA5 99FF00 4666 STA X0100-1,Y ;store digit
BEA8 C65D 4667 DEC Z5D ;decrement position of decimal point
BEAA D006 4668 BNE BBEB2 ;if position reached
BEAC A92E 4669 LDA ;set decimal point
BEAE C8 4670 INY
BEAF 99FF00 4671 STA X0100-1,Y ;and store it at next output location
BEB2 8471 4672 BBEB2 STY Z71 ;save output index
BEB4 A447 4673 LDY 247 ;restore table index
BEB6 8A 4674 TXA
BEB7 49FF 4675 EOR $FF ;inverse phase bit
BEB9 2980 4676 AND $80 ;reset digit
BEBB AA 4677 TAX
BECB C024 4678 CPY $24 ;if table index not at 9 (* 4)
BEBE F004 4679 BEQ BBEC4
BEC0 C03C 4680 CPY $3C ;and not at 15 (* 4)
BEC2 D0A6 4681 BNE BB6A ;repeat
BEC4 A471 4682 BBEC4 LDY Z71 ;if end of segment, restore output index
BEC6 B9FF00 4683 BBEC6 LDA X0100-1,Y ;get last digit
BEC9 88 4684 DEY
Beca C930 4685 CMP '0 ;if a "0"
BECF F0F8 4686 BEQ BBEC6 ;remove and repeat
BECF C92E 4687 CMP '.' ;if decimal point
BED0 F001 4688 BEQ BBED3 ;remove, but do not repeat
BED2 C8 4689 INY
BED3 A92B 4690 BBED3 LDA '+' ;set "+"
BED5 A65E 4691 LDX Z5E ;get exponent, base 10
BED7 F02E 4692 BEQ BBF07 ;if zero, go end string
BED9 1008 4693 BPL BBEE3
BEDB A900 4694 LDA $00 ;if negative,
BEDD 38 4695 SEC
BEDE E55E 4696 SBC Z5E ;compute complement of exponent
BEE0 AA 4697 TAX
BEE1 A92D 4698 LDA '-' ;and set "-"
BEE3 990101 4699 BBEE3 STA X0101,Y ;store sign of exponent in output area
BEE6 A945 4700 LDA '^' ;set sign for exponential notation
BEE8 990001 4701 STA X0100,Y ;and store it
BEEB 8A 4702 TXA
BEEC A22F 4703 LDX $2F ;get ASCII base for first exponent digit
BEEE 38 4704 SEC
BEEF E8 4705 BBEEF INX ;increment
BEFO E90A 4706 SBC $0A ;subtract 10 from exponent
BEF2 BOFB 4707 BCS BBEEF ;if not a borrow, repeat
BEF4 693A 4708 ADC $3A ;convert second exponent digit to ASCII
BEF6 990301 4709 STA X0103,Y ;store second digit
BEF9 8A 4710 TXA
BEFA 990201 4711 STA X0102,Y ;store first digit
BEFD A900 4712 LDA $00
BEFF 990401 4713 STA X0104,Y ;store end of string
BF02 F008 4714 BEQ BBF0C ;and exit

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```

BF04 99FF00 4715 JBF04 STA X0100-1,Y ;store A at current output position
BF07 A900 4716 BBFO7 LDA $00
BF09 990001 4717 STA X0100,Y ;store end of string
BF0C A900 4718 BBFOC LDA <X0100
BF0E A001 4719 LDY >X0100 ;set AY to point to string text
BF10 60 4720 RTS
4721 ;
4722 ;constants for conversions
4723 ;
4724 ;0.5 for rounding, SQR and dummy variable
BF11 800000 4725 TBF11 .BY $80,$00,$00,$00,$00
4726 ;
4727 ;divisors for decimal conversion
4728 ;
4729 ;-100000000
BF16 FA0A1F 4730 TBF16 .BY $FA,$0A,$1F,$00
4731 ;+10000000
BF1A 009896 4732 .BY $00,$98,$96,$80
4733 ;-1000000
BF1E FFFF0BD 4734 .BY $FF,$F0,$BD,$C0
4735 ;+100000
BF22 000186 4736 .BY $00,$01,$86,$A0
4737 ;-10000
BF26 FFFF0D8 4738 .BY $FF,$FF,$D8,$F0
4739 ;+1000
BF2A 000003 4740 .BY $00,$00,$03,$E8
4741 ;-100
BF2E FFFFFF 4742 .BY $FF,$FF,$FF,$9C
4743 ;+10
BF32 000000 4744 .BY $00,$00,$00,$0A
4745 ;-1
BF36 FFFFFF 4746 .BY $FF,$FF,$FF,$FF
4747 ;
4748 ;divisors for time conversion
4749 ;
4750 ;-10 * 6 * 10 * 6 * 10 * 60
BF3A FFDF0A 4751 .BY $FF,$D0,$0A,$80
4752 ;+6 * 10 * 6 * 10 * 60
BF3E 00034B 4753 .BY $00,$03,$4B,$C0
4754 ;-10 * 6 * 10 * 60
BF42 FFFF73 4755 .BY $FF,$FF,$73,$60
4756 ;+6 * 10 * 60
BF46 00000E 4757 .BY $00,$00,$0E,$10
4758 ;-10 * 60
BF4A FFFFFD 4759 .BY $FF,$FF,$FD,$A8
4760 ;+60
BF4E 000000 4761 .BY $00,$00,$00,$3C
4762 ;
4763 ;unused area follows
4764 ;
BF52 ECAAAA 4765 .BY $EC,$AA,$AA,$AA,$AA,$AA,$AA
BF5A AAAAAA 4766 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA
BF62 AAAAAA 4767 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA
BF6A AAAAAA 4768 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA

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        4770 ;"SQR" command
        4771 ;
BF71 200CBC 4772 WBF71 JSR SBCOC      ;move rounded flp accu into 2nd flp accu
BF74 A911 4773 LDA <TBF11
BF76 A0BF 4774 LDY >TBF11      ;let AY point to value 0.5
BF78 20A2BB 4775 JSR SBBA2      ;load flp accu from AY
        4776 ;
        4777 ;"EXPONENT" operation
        4778 ;
BF7B F070 4779 WBF7B BEQ BBFED      ;if right operand zero, do EXP(0)
BF7D A569 4780 LDA Z69      ;if left operand zero
BF7F D003 4781 BNE BBF84
BF81 4CF9B8 4782 JMP JB8F9      ;set result zero
        4783 ;
BF84 A24E 4784 BBF84 LDX <Z4E      ;set AY to Z4E
BF86 A000 4785 LDY >Z4E      ;store flp accu there
BF88 20D4BB 4786 JSR SBBD4      ;get sign of left operand
BF8B A56E 4787 LDA Z6E      ;if negative
BF8D 100F 4788 BPL BBF9E      ;perform INT
BF8F 20CCBC 4789 JSR SBCCC
BF92 A94E 4790 LDA <Z4E
BF94 A000 4791 LDY >Z4E      ;set AY to Z4E again
BF96 205BBC 4792 JSR SBC5B
BF99 D003 4793 BNE BBF9E      ;compare AY with flp accu
BF9B 98 4794 TYA      ;if equal, right operand = integer
BF9C A407 4795 LDY Z07      ;set positive
BF9E 20FEBB 4796 BBF9E JSR SBBFE      ;set sign change flag
BF9E 20FEBB 4796 BBF9E JSR SBBFE      ;move second flp accu into flp accu with
BFA1 98 4797 TYA
BFA2 48 4798 PHA      ;save sign change flag
BFA3 20EAB9 4799 JSR SB9EA      ;perform LOG
BFA6 A94E 4800 LDA <Z4E
BFA8 A000 4801 LDY >Z4E      ;set AY to Z4E
BFAA 2028BA 4802 JSR SBA28      ;multiply AY by flp accu
BFAD 20EDBF 4803 JSR BBFED      ;perform EXP
BFBD 68 4804 PLA      ;restore sign change flag
BFB1 4A 4805 LSR A      ;shift into carry
BFB2 900A 4806 BCC BBFBF      ;return if not set, else do monadic "--"
        4807 ;
        4808 ;"MINUS" operator
        4809 ;
BFB4 4810 WBBF4 =   *
BFB4 A561 4811 JBFB4 LDA Z61      ;if number = 0
BFB6 F006 4812 BEQ BBFBE      ;so is result
BFB8 A566 4813 LDA Z66
BFBA 49FF 4814 EOR $FF      ;else invert sign
BFBC 8566 4815 STA Z66
BFBF 60 4816 BBFBF RTS

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4818 ;floating point numbers for EXP
4819 ;
4820 ;1/LOG(2)
BFBF 8138AA 4821 TBFBF .BY $81,$38,$AA,$3B,$29
BFC4 07    4822 .BY $07           ;polynome table for EXP
4823 ;0.0000214987637
BFC5 713458 4824 .BY $71,$34,$58,$3E,$56
4825 ;0.000143523140
BFCA 74167E 4826 .BY $74,$16,$7E,$B3,$1B
4827 ;0.00134226348
BFCF 772FEE 4828 .BY $77,$2F,$EE,$E3,$85
4829 ;0.00961401701
BFD4 7A1D84 4830 .BY $7A,$1D,$84,$1C,$2A
4831 ;0.0555051269
BFD9 7C6359 4832 .BY $7C,$63,$59,$58,$0A
4833 ;0.240226385
BFDE 7E75FD 4834 .BY $7E,$75,$FD,$E7,$C6
4835 ;0.693147186
BFE3 803172 4836 .BY $80,$31,$72,$18,$10
4837 ;1.0
BFE8 810000 4838 .BY $81,$00,$00,$00,$00
4839 ;
4840 ;"EXP" command
4841 ;
BFED 4842 WBFED = *
BFED A9BF 4843 BBFED LDA <TBFBF
BFFF A0BF 4844 LDY >TBFBF ;let AY point to 1/LOG(2)
BFF1 2028BA 4845 JSR SBA28 ;multiply AY times flp accu
BFF4 A570 4846 LDA Z70
BFF6 6950 4847 ADC $50 ;according to guard byte + 80
BFF8 9003 4848 BCC BBFFD
BFFA 2023BC 4849 JSR SBC23 ;round flp accu
BFFD 4C00EO 4850 BBFFD JMP XE000 ;continue in part 2

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BA38F	A38F	503
BA3A4	A3A4	489
BA3B0	A3B0	495
BA3B7	A3B7	487 498
BA3DC	A3DC	535
BA3E8	A3E8	547
BA3EC	A3EC	541 543 553
BA3F3	A3F3	530
BA412	A412	574
BA416	A416	583
BA421	A421	589
BA434	A434	573 576 594
BA435	A435	563 567 595 597 2854
BA456	A456	631
BA474	A474	638
BA480	A480	654 716 744
BA49C	A49C	657
BA4D7	A4D7	694
BA4DF	A4DF	699 705 709
BA4ED	A4ED	667
BA508	A508	724
BA522	A522	741
BA53C	A53C	772
BA544	A544	759
BA55F	A55F	755
BA562	A562	784
BA576	A576	780
BA582	A582	802 847
BA58E	A58E	798
BA5A4	A5A4	811
BA5AC	A5AC	815
BA5B6	A5B6	829
BA5B8	A5B8	863
BA5C7	A5C7	865
BA5C9	A5C9	800 804 809 813 817 850 852
BA5DC	A5DC	841
BA5DE	A5DE	843
BA5E5	A5E5	856
BA5EE	A5EE	807
BA5F5	A5F5	831
BA5F9	A5F9	861
BA609	A609	838
BA617	A617	903 1298
BA62E	A62E	890
BA637	A637	892
BA640	A640	884
BA641	A641	889 896 897 909 980 983
BA68D	A68D	927 974
BA6A4	A6A4	971 972
BA6BB	A6BB	978
BA6C9	A6C9	988 1033
BA6E6	A6E6	1007
BA6E8	A6E8	1009
BA6EF	A6EF	1061
BA6F3	A6F3	1040 1042 1044
BA700	A700	1018
BA714	A714	998 1010 1023
BA717	A717	1025
BA72C	A72C	1055

BA72F	A72F	1054
BA737	A737	1051 1063
BA753	A753	1071
BA79F	A79F	1111
BA7BE	A7BE	1130
BA7CE	A7CE	1139
BA804	A804	1165
BA807	A807	1135
BA80B	A80B	1183
BA80E	A80E	1167
BA827	A827	1196 1923
BA82B	A82B	1163
BA832	A832	1206
BA849	A849	1216
BA854	A854	1227
BA862	A862	1236
BA870	A870	1211 1233
BA87D	A87D	1254
BA8BC	A8BC	1288
BA8C0	A8C0	1293 1295
BA8D1	A8D1	1310
BA8E3	A8E3	1299
BA8E8	A8E8	1398
BA8EB	A8EB	1316
BA8FB	A8FB	1382 1800 1912
BA905	A905	1342 1360 1362
BA911	A911	1366
BA919	A919	1365
BA937	A937	1373
BA940	A940	1377
BA948	A948	1387
BA953	A953	1426
BA957	A957	1396 1406
BA95F	A95F	1400
BA96A	A96A	1420
BA99F	A99F	1442
BA9D6	A9D6	1465
BA9D9	A9D9	1463
BA9ED	A9ED	1513
BAA07	AA07	1506
BAA24	AA24	1494
BAA27	AA27	1525
BAA2C	AA2C	1488
BAA3D	AA3D	1537
BAA4B	AA4B	1536 1541 1544
BAA52	AA52	1545 1548
BAA90	AA90	1589
BAA9A	AA9A	1617
BAA9D	AA9D	1622
BAAE5	AAE5	1640 1698
BAAE7	AAE7	1605 1633 1692
BAAE8	AAE8	1612
BAAE8E	AAAE	1656
BAAF8	AAF8	1607 1610
BAB0E	ABOE	1659
BABOF	ABOF	1668
BAB10	AB10	1679
BAB13	AB13	1614 1671
BAB19	AB19	1675
BAB28	AB28	1697 1699

BAB42	AB42	1704
BAB57	AB57	1718
BAB5B	AB5B	1720
BAB5F	AB5F	1666
BAB62	AB62	1717
BAB6B	AB6B	1727
BAB92	AB92	1744
BABB7	ABB7	1758
BABD6	ABD6	1798
BABEA	ABEA	1788 1791
BAC03	AC03	1805
BAC0D	AC0D	1796
BAC41	AC41	1834
BAC4A	AC4A	1842
BAC4D	AC4D	1839
BAC51	AC51	1832 1917
BAC65	AC65	1851
BAC71	AC71	1856
BAC72	AC72	1859
BAC7D	AC7D	1868
BAC89	AC89	1849
BAC9D	AC9D	1879 1881
BACB8	ACB8	1840 1916
BACD1	ACD1	1900
BACDF	ACDF	1893
BACEA	ACEA	1922
BACFB	ACFB	1927 1929
BAD27	AD27	1946
BAD32	AD32	1904
BAD35	AD35	1951
BAD75	AD75	1994
BAD78	AD78	1977
BAD96	AD96	2016
BAD97	AD97	2012
BAD99	AD99	2013
BADA4	ADA4	2023
BADD7	ADD7	2039 2041
BADE8	ADE8	2058
BADFO	ADFO	2087
BADF9	ADF9	2090
BAE07	AE07	2053
BAE11	AE11	2082
BAE19	AE19	2074
BAE30	AE30	2047
BAE58	AE58	2054 2056
BAE5B	AE5B	2076
BAE5D	AE5D	2068
BAE64	AE64	2135
BAE66	AE66	2077 2089
BAE80	AE80	2133
BAE8A	AE8A	2188
BAE8F	AE8F	2184
BAE92	AE92	2165
BAE9A	AE9A	2169
BAEAD	AEAD	2173
BAEC6	AEC6	2194
BAECC	AECC	2190
BAEE3	AEE3	2200
BAEEA	AAA	2217
BAEF1	AEF1	2221 2364 3008

BAF0D	AF0D 2186
BAFOF	AFOF 2202
BAF27	AF27 2256
BAF5C	AF5C 2275 2277 2279
BAF5D	AF5D 2271
BAF6E	AF6E 2293
BAF92	AF92 2306
BAFA0	AFA0 2304 2308 2327 2329
BAFD1	AFD1 2344
BB02E	B02E 2406
BB056	B056 2432 2434
BB05B	B05B 2449
BB066	B066 2442
BB072	B072 2444 2446 2451
BB07B	B07B 2457
BB07E	B07E 2467
BB09C	B09C 2501
BB09F	B09F 2478
BB0AF	BOAF 2485
BB0B0	BOB0 2490 2492
BB0BA	BOBA 2487
BB0C4	BOC4 2494
BB0D4	BOD4 2497
BB0DB	BODB 2499
BB0E7	BOE7 2514
BB0EF	BOEF 2540
BB0F1	BOF1 2538
BB0FB	BOFB 2524
BB109	B109 2529
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BB11D	B11D 2526
BB123	B123 2569
BB128	B128 2559
BB138	B138 2577
BB13B	B13B 2567 2571
BB143	B143 2575
BB159	B159 2588
BB185	B185 2533
BB18F	B18F 2622
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BB1CE	B1CE 2664
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BB237	B237 2725
BB245	B245 2750 2853
BB24A	B24A 2745
BB24D	B24D 2728
BB261	B261 2720
BB274	B274 2762
BB27D	B27D 2767
BB286	B286 2796
BB296	B296 2779
BB2B9	B2B9 2803
BB2C8	B2C8 2815 2818
BB2CD	B2CD 2812
BB2F2	B2F2 2870
BB308	B308 2848
BB30B	B30B 2798 2805 2911 2922

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BB331	B331	2874
BB337	B337	2877
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BB384	B384	2930
BB3AE	B3AE	3020
BB418	B418	3026
BB449	B449	3048
BB497	B497	3111
BB4A4	B4A4	3109
BB4A8	B4A8	3107
BB4A9	B4A9	3113
BB4B5	B4B5	3120
BB4BF	B4BF	3124
BB4CA	B4CA	3126 3382 3480 3508
BB4D2	B4D2	3184
BB4D5	B4D5	3137
BB4F6	B4F6	3189
BB501	B501	3167
BB50B	B50B	3171
BB516	B516	3170 3173
BB544	B544	3211
BB54D	B54D	3209
BB559	B559	3223
BB561	B561	3219
BB566	B566	3221
BB56E	B56E	3252 3254
BB572	B572	3268
BB57D	B57D	3231 3233
BB5AE	B5AE	3262
BB5B0	B5B0	3270
BB5B8	B5B8	3266
BB5DC	B5DC	3294
BB5E6	B5E6	3300
BB5F6	B5F6	3276 3279 3287 3295 3297 3299 3302
BB601	B601	3315 3325
BB65D	B65D	3369
BB690	B690	3411
BB699	B699	3405
BB6A2	B6A2	3416
BB6D5	B6D5	3449
BB6D6	B6D6	3440 3442 3444
BB6EB	B6EB	3459 3461
BB70C	B70C	3487
BB70D	B70D	3535
BB70E	B70E	3538 3540
BB725	B725	3504
BB748	B748	3524
BB798	B798	3528 3579 3593 3642 3645
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BB7CD	B7CD	3613
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BB840	B840	3690
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BB86F	B86F	3723

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BB8D7	B8D7 3778 4195
BB8DB	B8DB 3796
BB8FE	B8FE 3754
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BB929	B929 3784
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BB97D	B97D 3866 3871 3873 3875
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BB9BA	B9BA 3901
BB9F1	B9F1 3941
BB9F4	B9F4 3942
BBA30	BA30 3973
BBA61	BA61 4023
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BBACF	BACF 4066
BBADA	BADA 4056 4063
BBADF	BADF 4060 4075 4089 4094 4125
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BBB3F	BB3F 4130 4133 4136 4153 4155
BBB4C	BB4C 4141 4173
BBB5D	BB5D 4148
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BBB7E	BB7E 4145
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BBC02	BC02 4270
BBC11	BC11 4281
BBC1A	BC1A 4288 4290 4292
BBC2F	BC2F 4343
BBC38	BC38 4298 4302
BBC92	BC92 4345 4349 4353 4357
BBC98	BC98 4365
BBCAF	BCAF 4376
BBCBA	BCBA 4363
BBCBB	BCBB 4384
BBCE9	BCE9 4372
BBCF2	BCF2 4404
BBCF7	BCF7 4432
BBD06	BD06 4435
BBD0A	BDOA 4437 4469 4498
BBD0D	BDOD 4433
BBD0F	BDOF 4439
BBD2E	BD2E 4449 4451
BBD30	BD30 4453 4455 4533
BBD33	BD33 4447
BBD35	BD35 4456
BBD41	BD41 4443
BBD47	BD47 4445 4461
BBD52	BD52 4478
BBD5B	BD5B 4475 4482
BBD62	BD62 4474 4479
BBD67	BD67 4484

BB6A	BD6A	4441
BBD71	BD71	4491
BBD91	BD91	4459
BBDAO	BDAO	4516
BBDAE	BDAE	4519
BBDE7	BDE7	4567
BBDF8	BDF8	4575
BBEOO	BE00	4580
BBE09	BE09	4581
BBEBB	BE0B	4602
BBE16	BE16	4599
BBE21	BE21	4595
BBE28	BE28	4591
BBE2F	BE2F	4596
BBE32	BE32	4590
BBE47	BE47	4609
BBE48	BE48	4611
BBE53	BE53	4620
BBE64	BE64	4627
BBE66	BE66	4621
BBE6A	BE6A	4649 4651 4681
BBE8E	BE8E	4648
BBE90	BE90	4650
BBE97	BE97	4653
BBEB2	BEB2	4668
BBEC4	BEC4	4679
BBEC6	BEC6	4686
BBED3	BED3	4688
BBEE3	BEE3	4693
BBEEF	BEEF	4707
BBF07	BF07	4692
BBFOC	BFOC	4714
BBF84	BF84	4781
BBF9E	BF9E	4788 4793
BBFBF	BFBF	4806 4812
BBFFD	BFED	4779 4803
BBFFD	BFFD	4848
JA437	A437	786 1237 1320 1729 1953 2018 2240 2742 2964 3139 3371 3880 4185
JA469	A469	1228
JA7AE	A7AE	1159 1276 1986
JA7E1	A7E1	659 1151 1179
JA7EF	A7EF	1402
JA84B	A84B	1140
JA897	A897	1258
JA8AO	A8AO	1187 1275 1388
JA8F8	A8F8	1793 2987
JA971	A971	1445
JAA68	AA68	1551
JAAA0	AAA0	1596
JAAA2	AAA2	1677
JAACA	AACA	788
JAB4D	AB4D	1882
JABB5	ABB5	1583 1792
JAC15	AC15	1895
JAC91	AC91	1873
JADA9	ADA9	2100
JADB8	ADB8	3383
JADBB	ADBB	2050
JADFA	ADFA	2247

JAE43	AE43	1104
JAF08	AF08	1180 1322 1725 2102 2236 2479 2572 3049
JAF28	AF28	2170
JAF47	AF47	2222
JAFD6	AFD6	2362
JB061	B061	2415
JB1D1	B1D1	2515
JB248	B248	1526 2668 3585 3943
JB2EA	B2EA	2751
JB391	B391	2212 2301 2401 2954
JB3A2	B3A2	3568 3583 3667
JB3F4	B3F4	2218
JB44F	B44F	2988
JB46F	B46F	2288
JB52A	B52A	3351
JB606	B606	3234
JB63D	B63D	2059
JB706	B706	3516
JB86A	B86A	3711 4510
JB8D2	B8D2	4325 4415
JB8F7	B8F7	3601 3831 4078
JB8F9	B8F9	4782
JB8FB	B8FB	4067
JB936	B936	3818
JB938	B938	4293
JB983	B983	3997
JBA8B	BA8B	3974
JBB12	BB12	4108
JBB4F	BB4F	4170
JBB8F	BB8F	3992 4182
JBBDO	BBDO	1481 1971
JBC31	BC31	4367
JBC3C	BC3C	2331 2459 4505
JBC44	BC44	2947
JBC4F	BC4F	2312
JBD49	BD49	4465
JBD7E	BD7E	1529 3966 4497
JBF04	BF04	4576
JBFB4	BFB4	4487
SA38A	A38A	1070 1313 1950
SA3B8	A3B8	727 2592
SA3BF	A3BF	3341
SA3FB	A3FB	1079 1263 2032
SA408	A408	508 2756 2806
SA533	A533	714 743
SA560	A560	649 1808
SA579	A579	658 664
SA613	A613	666 976
SA659	A659	713 742 1255
SA660	A660	1257
SA67A	A67A	632
SA68E	A68E	922
SA7ED	A7ED	1158 1389
SA81D	A81D	939
SA82C	A82C	999 1125
SA906	A906	1080 1337 1799 1897
SA909	A909	1282 1381
SA96B	A96B	663 975 982 1281 1404
SA9A5	A9A5	1069 1176
SA9C2	A9C2	1877

SA9DA	A9DA	1872
SAA1D	AA1D	1499 1503
SAA86	AA86	1582
SAAD7	AAD7	622 1000 1604
SAB1E	AB1E	635 642 1733 1932 4560
SAB21	AB21	1598 1620 1782
SAB3B	AB3B	1621 1678 1807
SAB45	AB45	623 1806 1843
SAB47	AB47	628 1016 1062 1638 1642 1694
SABCE	ABCE	1768 1778
SABF9	ABF9	1786 1844
SACOF	ACOF	1756
SAD24	AD24	1944 1996
SAD8A	AD8A	1095 1113 3042 3590 3634
SAD8D	AD8D	1094 2069 2136 2372 2656 2974 2999 3009 3074
SAD8F	AD8F	2348 3360 3422
SAD90	AD90	1462 2405
SAD9E	AD9E	1370 1459 1615 2000 2225 2346 2655
SAE20	AE20	2071
SAE33	AE33	2098
SAE38	AE38	1115
SAE83	AE83	2033 3359
SAEBD	AEBD	1779
SAEF7	AEF7	2706 2975 3544
SAEFA	AEFA	2224 2345 2970
SAEFD	AEFD	1894 2347 2463 3525 3636
SAEFF	AEFF	1093 1186 1375 1454 1591 1748 1765 1781 2977 2993
SAF14	AF14	2274 2303
SAF84	AF84	2280 2309
SB08B	B08B	1450 1820 1947 2265 2973
SB090	B090	2465
SB092	B092	2996
SB113	B113	2168 2477 2486 2491
SB194	B194	2746 2755
SB1B2	BLB2	2685
SB1B8	BLB8	3591
SB1BF	BLBF	1470 2206 2383 2391 2647
S834C	B34C	2791 2861
SB355	B355	2882
S83A6	B3A6	1742 1783 2969
S83E1	B3E1	2968 3003
S8475	B475	1555 3128 3373
S847D	B47D	3474 3494
SB487	B487	1619 1683 2196 3081
SB48D	B48D	1870
S84F4	B4F4	3089
S8526	B526	584 2932 3185
SB5BD	B5BD	3222
SB5C7	B5C7	3210 3269
SB67A	B67A	1560 3374
SB688	B688	3131
SB68C	B68C	3378 3507
SB6A3	B6A3	3570
SB6A6	B6A6	1492 1687 2420 2931
S86AA	B6AA	2426 3377 3381 3497
SB6DB	B6DB	1568 3427
SB761	B761	3484 3512 3527
SB782	B782	3567 3578 3599
SB79B	B79B	1664
SB79E	B79E	1393 1588 1746 1763 2357 3526 3637

SB7A1	B7A1	3470
SB7E2	B7E2	1871 2197
SB7EB	B7EB	3671 3679
SB7F1	B7F1	3684
SB7F7	B7F7	3635 3659
SB849	B849	4603
SB850	B850	3958
SB867	B867	1970 3697 3952 3964
SB877	B877	4092
SB947	B947	3779
SB94D	B94D	4380
SB96F	B96F	4291
SB999	B999	3713 4385
SB9B0	B9B0	3752 4395
SB9EA	B9EA	4799
SBA28	BA28	4584 4802 4845
SBA59	BA59	3983 3985 3987 3989
SBA5E	BA5E	3991 3996
SBA8C	BA8C	3701 3718 3969 4112
SBA87	BAB7	3976 4123
SBAE2	BAE2	1500 1514 4480 4493 4597
SBAED	BAED	1509
SBAFE	BAFE	4476 4600
SBBQF	BBQF	3955
SBBA2	BBA2	1108 1964 2176 2335 4107 4775
SBBB4	BBB4	3028 4230 4786
SBBFC	BBFC	2390 3724
SBBFE	BBFE	4796
SBC0C	BC0C	1504 4084 4102 4503 4772
SBC1B	BC1B	1469 2116 4118 4239 4276
SBC23	BC23	4849
SBC2B	BC2B	1114 3940 4308 4340
SBC49	BC49	4558
SBC5B	BC5B	2413 2667 4589 4594 4792
SBC5D	BC5D	1973
SBC9B	BC9B	1515 2669 3646 4405 4604
SBCCC	BCCC	4789
SBCF3	BCF3	1875 2166 3622
SBDC2	BDC2	639
SBDCD	BDCD	1012
SBDDA	BDAA	4548
SBDDD	BDDD	1618
SBDDF	BDDF	3076 4559
SBE68	BE68	2287
TA00C	A00C	1170 1172
TA080	A080	2067 2088 2094 2096 2107
TA09E	A09E	828 860 862 1053 1060
TA19E	A19E	433
TA1AC	A1AC	434
TA1B5	A1B5	435
TA1C2	A1C2	436
TA1DO	A1DO	437
TA1E2	A1E2	438
TA1FO	A1FO	439
TA1FF	A1FF	440
TA21O	A21O	441
TA225	A225	442
TA235	A235	443
TA23B	A23B	444
TA24F	A24F	445

TA25A	A25A	446
TA26A	A26A	447
TA272	A272	448
TA27F	A27F	449
TA290	A290	450
TA29D	A29D	451
TA2AA	A2AA	452
TA2BA	A2BA	453
TA2C8	A2C8	454
TA2D5	A2D5	455
TA2E4	A2E4	456
TA2ED	A2ED	457
TA300	A300	458
TA30E	A30E	459
TA31E	A31E	460
TA324	A324	461
TA328	A328	615 617
TA364	A364	
TA369	A369	633 634
TA371	A371	4546 4547
TA376	A376	640 641
TA381	A381	1225 1226
TA383	A383	462
TACFC	ACFC	1930 1931
TADOC	ADOC	1731 1732
TAEEA8	AEA8	2174 2175
TB1A5	B1A5	2665 2666
TB9BC	B9BC	1106 1107 3956 3957
TB9C1	B9C1	3959 3960
TB9D6	B9D6	3950 3951
TB9DB	B9DB	3953 3954
TB9E0	B9E0	3962 3963
TB9E5	B9E5	3967 3968
TBAF9	BAF9	4103 4104
TBDB3	BDB3	4592 4593
TBDB8	BDB8	4587 4588
TBDBD	BDBD	4582 4583
TBF11	BF11	3695 3696 4773 4774
TBF16	BF16	4636 4639 4642 4645
TBFBF	BFBF	4843 4844
W0314	0314	
W0316	0316	
W0318	0318	
W031A	031A	
W031C	031C	
W031E	031E	
W0320	0320	
W0322	0322	
W0324	0324	
W0326	0326	
W0328	0328	
W032A	032A	
W032C	032C	
W032E	032E	
W0330	0330	
W0332	0332	
WA642	A642	240
WA65E	A65E	234
WA69C	A69C	233
WA742	A742	207

WA78B	A78B	1100	1101
WA81D	A81D	218	
WA82F	A82F	222	
WA831	A831	206	
WA857	A857	232	
WA871	A871	216	
WA883	A883	219	
WA8AO	A8AO	215	
WA8D2	A8D2	220	
WA8F8	A8F8	209	
WA928	A928	217	
WA93B	A93B	221	
WA94B	A94B	223	
WA9A5	A9A5	214	
WAA80	AA80	230	
WAA86	AA86	235	
WAAA0	AAA0	231	
WAB7B	AB7B	239	
WABA5	ABA5	210	
WABBF	ABBF	211	
WAC06	AC06	213	
WAD1E	AD1E	208	
WAED4	AED4	296	
WAFE6	AFE6	290	
WAFE9	AFE9	287	
WB016	B016	299	
WB081	B081	212	
WB37D	B37D	248	
WB39E	B39E	249	
WB3B3	B3B3	228	
WB465	B465	260	
WB6EC	B6EC	263	
WB700	B700	264	
WB72C	B72C	265	
WB737	B737	266	
WB77C	B77C	259	
WB78B	B78B	262	
WB7AD	B7AD	261	
WB80D	B80D	258	
WB824	B824	229	
WB82D	B82D	224	
WB853	B853	275	
WB86A	B86A	272	
WB9EA	B9EA	252	
WBA2B	BA2B	278	
WBBL2	BBL2	281	
WBC39	BC39	244	
WBC58	BC58	246	
WBCCC	BCCC	245	
WBF71	BF71	250	
WBF7B	BF7B	284	
WBFB4	BFB4	293	
WBFED	BFED	253	
WE097	E097	251	
WE12A	E12A	236	
WE156	E156	226	
WE165	E165	227	
WE168	E168	225	
WE1BE	E1BE	237	
WE1C7	E1C7	238	

WE264	E264	254
WE26B	E26B	255
WE2B4	E2B4	256
WE30E	E30E	257
WE37B	E37B	197
WE394	E394	196
X0054	0054	2371
X0073	0073	652 981 1112 1157 1174 1184 1403 1444 1676 1745 1847 1995 2049 2164 2177 2237 2342 2484 2489 2509 2654 3589 4440 4446 4458
X0079	0079	977 1109 1274 1371 1386 1599 1831 1878 1892 1913 1992 2036 2466 2473 2476 2702 3047 3522 3595 3621 3682
X0080	0080	1524
X0100	0100	1966 1976 1978 1980 1982 1984 4569 4625 4630 4666 4671 4683 4701 4715 4717 4718 4719
X0101	0101	485 2695 2700 4699
X0102	0102	490 497 2693 2698 4711
X0103	0103	492 494 4709
X0104	0104	4713
X01FE	01FE	730
X01FF	01FF	731 1785
X0200	0200	715 738 781 797 826 836 837 849 854 864 866 1629 1754 1795 1836
X0300	0300	608
X0302	0302	645
X0304	0304	790
X0306	0306	1036
X0308	0308	1153
X030A	030A	2158
X0310	0310	247
X9FEA	9FEA	2367 2369
XE000	E000	4850
XE043	E043	3961
XE10C	E10C	1710
XE112	E112	778
XE118	E118	1594
XE11E	E11E	1750 1767
XE124	E124	1835
XE386	E386	1034 1229
XFF90	FF90	644 1252
XFFB7	FFB7	1789 2330
XFFCC	FFCC	619 1770
XFFDB	FFDB	1519
XFFDE	FFDE	2316
XFFE1	FFE1	1202
XFFE7	FFE7	928
XFFF0	FFF0	1652 1662 2952
Z00	0000	3141
Z01	0001	3143 3751 3775 3776 3891 3894 3902 3904 3905 3906
Z02	0002	3145 3772 3773 3889 3892 3907
Z03	0003	3769 3770 3887 3890 3908
Z04	0004	3766 3767 3885 3888 3909
Z07	0007	1352 1356 1357 1422 1440 1855 1857 1861 2386 2399 3098 3108 4414 4795
Z08	0008	805 848 851 1354 1355 1358 1361 1864 2389 2394 3099 3110
Z09	0009	1663 1670
Z0B	000B	665 720 736 820 832 858 2382 2385 2388 2393 2395 2398 2400 2630 2705 2747 2771 2795 2836 2869
Z0C	000C	2474 2673 2712 2744 2778 2829
Z0D	000D	1457 1616 1848 2011 2057 2078 2163 2270 2418 2482 2496 2676

	2708	2929	2943	3151	3572								
Z0E	000E	1455	1876	2292	2483	2503	2674	2710					
Z0F	000F	796	808	844	996	1019	1021	1043	3161	3183	3187		
Z10	0010	955	1068	2500	2512	2518	2972	2995					
Z11	0011	1716	1817	1833	1850	1921							
Z12	0012	2140	2456										
Z13	0013	621	1593	1632	1639	1703	1726	1749	1757	1766	1769	1772	1787
		1797	1804	1841	1928								
Z14	0014	728	893	986	990	1008	1285	1418	1427	1432	1433	1437	1439
		1441	3649	3657	3661	3664	3674	3687					
Z15	0015	729	887	987	991	1006	1287	1419	1423	1435	1436	1438	1443
		3650	3655	3666									
Z16	0016	944	3135	3156	3208	3462							
Z17	0017	3152	3460	3464									
Z18	0018	3458											
Z19	0019	943	3204	3205									
Z22	0022	523	533	539	564	566	616	625	675	698	702	750	754
		758	762	765	769	770	1102	1424	1429	1431	1434	1523	1693
		2062	2064	2110	2111	2127	2794	2866	2895	3136	3206	3216	3235
		3238	3241	3244	3248	3256	3260	3261	3275	3278	3286	3289	3292
		3305	3313	3314	3402	3408	3425	3430	3433	3436	3452	3502	3503
		3581	3606	3609	4028	4031	4034	4037	4040	4048	4199	4202	4205
		4208	4211	4216	4240	4244	4247	4250	4255	4258			
Z23	0023	618	673	700	706	751	766	771	1103	2113	3207	3217	3236
		3263	3264	3306	3316	3317	3403	3426	3453	3505	3611	4029	4200
		4241											
Z24	0024	684	703	1961	3610	3617	3620	3625	4334	4337	4341	4346	4351
		4355	4361										
Z25	0025	677	696	707	3615	4335							
Z26	0026	3978	4013	4015	4016	4187							
Z27	0027	3979	4010	4012	4017	4189							
Z28	0028	2880	2897	2917	3980	4007	4009	4018	4191				
Z29	0029	2920	2920	3981	4004	4006	4019	4143	4193				
Z2B	002E	748	378	912	914	915	961	1193	1296				
Z2C	002C	749	879	919	964	1195	1297						
Z2D	002D	674	682	683	692	718	734	918	933	1547	2519	3214	
Z2E	002E	685	687	722	735	921	934	1543	2520	3215			
Z2F	002F	935	2525	2578	2596	2713	3220						
Z30	0030	936	2523	2579	2597	2714	3218						
Z31	0031	509	732	937	2582	2719	2807	2821	2935	3172	3200	3232	
Z32	0032	510	733	938	2583	2717	2808	2825	2938	3169	3201	3230	
Z33	0033	575	596	931	1540	2934	3165	3174	3195	3296	3337	3443	3447
		3448											
Z34	0034	572	593	932	1535	2937	3166	3175	3196	3293	3338	3441	3450
Z35	0035	3176	3409	3414	3415								
Z36	0036	3177	3417										
Z37	0037	929	3193										
Z38	0038	930	3194										
Z39	0039	1090	1144	1219	1244	1270	1284	1326	1723	1979	4550		
Z3A	003A	636	656	1088	1147	1214	1220	1245	1268	1286	1328	1724	1981
		2958	4549										
Z3B	003L	1221	1242										
Z3C	003C	1222	1243										
Z3D	003D	1131	1217	1239	1734								
Z3E	003E	954	1132	1218	1235	1735							
Z3F	003F	1721	1907										
Z40	0040	1722	1911										
Z41	0041	1196	1s12										
Z42	0042	1199	1813										
Z43	0043	1818	1827	1886	1919	1926							

Z44	0044	1819	1828	1887	1920
Z45	0045	2268	2475	2504	2505
Z46	0046	2269	2510	2530	2565
Z47	0047	2624	2885	2890	2981
Z48	0048	2625	2888	2979	3021
Z49	0049	491	496	1011	1014
				1048	1118
				1451	1473
				1476	1571
				1577	
Z4A	004A	486	493	1116	1312
Z4B	004B	1825	1888	2073	2137
Z4C	004C	1826	1889		
Z4D	004D	2035	2045	2046	2048
Z4E	004E	2997	3006	3011	3015
				3019	3033
				3036	3044
				3057	3060
				3063	3066
		3069	3199	3307	3324
				3331	3345
				3350	4784
				4785	4790
				4791	4800
Z4F	004F	2998	3004	3013	3046
Z50	0050	1556	1566	1570	1573
				1576	3084
				3375	3485
				3488	3495
				3514	3534
			3554		
Z51	0051	1557	1567	3085	3376
Z53	0053	3213	3227	3309	3311
Z55	0055	2368	3310	3326	3330
Z56	0056	2370	3272	3742	3764
Z57	0057	581	4228	4229	
Z58	0058	538	540	545	549
				721	2590
				2593	2637
				2802	2814
				2884	3224
Z59	0059	542	551	726	2591
				2594	2638
				2797	2799
				2816	2819
				2887	3225
Z5A	005A	521	531	534	544
Z5B	005B	525	536	550	723
Z5C	005C	4223			
Z5D	005D	2285	2902	2923	4430
Z5E	005E	2281	4464	4470	4473
Z5F	005F	522	672	678	680
				691	739
				881	883
				888	895
				899	902
		997	1002	1005	1024
				1027	1030
				1031	1300
				2522	2528
				2532	2536
		2580	2600	2603	2606
				2610	2612
				2614	2618
				2633	2715
		2727	2730	2732	2735
				2749	2761
				2766	2775
				2787	2790
				2822	2824
		2828	2835	2846	2851
				2896	2899
				3202	3301
				3303	3332
				4467	4468
Z60	0060	526	676	688	882
				1032	1303
				2521	2581
				2621	2634
				2716	2736
		2827	3203	3298	3304
				3334	4268
				4278	4457
				4460	4518
Z61	0061	587	1376	1496	1561
				1562	2125
				2155	2421
				2421	2431
				2435	2662
		3115	3140	3643	3710
				3733	3736
				3798	3830
				3834	3836
				3945	3949
		4050	4056	4065	4093
				4121	4122
				4124	4217
				4257	4287
				4297	4322
		4344	4371	4402	4412
				4509	4574
				4811	
Z62	0062	1098	1099	2123	2321
				2422	2448
				2944	3090
				3102	3142
				3142	3477
		3783	3786	3815	3817
				3827	3838
				3850	3852
				3876	3990
				4129	4167
		4188	4214	4254	4312
				4316	4348
				4392	4393
				4394	4419
				4554	4644
		4646			
Z63	0063	1517	2121	2318	2423
				2945	3091
				3103	3144
				3144	3774
				3785	3788
				3812	
		3814	3826	3839	3853
				3853	3874
				3988	4132
				4164	4190
				4209	4249
		4314	4354	4420	4555
				4641	4643
Z64	0064	1472	1516	1534	1539
				1546	1549
				1554	2119
				2210	2252
				2252	2258
		2295	2298	2317	2333
				2353	2384
				2397	2648
				2648	2697
				2697	2843
		3147	3357	3368	3423
				3592	3647
				3771	3787
				3787	3790
				3809	3811
				3825	
		3840	3856	3858	3872
				3986	4135
				4161	4192
				4206	4246
				4321	4356
		4421	4638	4640	
Z65	0065	1399	1475	1518	1542
				1550	2117
				2207	2254
				2260	2267
				2319	2334
		2351	2387	2392	2649
				2699	2845
				2845	2867
				3083	3148
				3148	3355
				3355	3424
		3537	3539	3594	3648
				3768	3789
				3792	3806
				3808	3824
				3841	3859
		3861	3870	3984	4138
				4158	4194
				4203	4243
				4243	4320
				4320	4362
				4362	4413
				4413	4422
		4634	4637		

Z66	0066	1096	1497	1967	2106	2153	2437	2443	2657	3641	3705	3707	3738
		3799	3847	3e49	4042	4070	4073	4212	4252	4265	4289	4324	4329
		4342	4364	4375	4390	4407	4408	4507	4566	4570	4813	4815	
Z67	0067	4436	4483										
Z68	0068	3893	4267	4279	4379	4386	4396						
Z69	0069	2142	2411	2412	3729	4049	4055	4780					
Z6A	006A	2144	2409	2410	3816	4014	4046	4128	4152	4166	4168		
Z6B	006B	2146	3813	4011	4038	4131	4151	4163	4165				
Z6C	006C	2148	2424	2427	2447	3810	4008	4035	4134	4150	4160	4162	
Z6D	006D	2150	2425	2428	3807	4005	4032	4137	4149	4157	4159		
Z6E	006E	2152	2407	3708	3737	4041	4044	4264	4506	4787			
Z6F	006F	1558	2154	3100	3106	3117	3129	3362	3366	3379	3389	3392	3395
		3709	3753	4043	4069	4091	4106	4508					
Z70	0070	1559	2273	3101	3119	3123	3130	3149	3364	3380	3726	3746	3750
		3765	3791	3793	3805	3823	3842	3862	3864	3865	3886	3900	3982
		4020	4180	4218	4259	4271	4282	4289	4323	4360	4406	4846	
Z71	0071	818	833	1496	1501	1502	1510	2283	2770	2792	2811	2838	2858
		2868	2912	3118	3604	3626	4571	4622	4631	4662	4672	4682	
Z72	0072	2758	2793	2810	2817	2839	2857	2871	2913	3122	3605	3627	
Z7A	007A	650	794	822	857	869	963	1083	1126	1134	1137	1143	1146
		1149	1150	1212	1240	1266	1291	1302	1330	1340	1341	1359	1736
		1823	1e29	1845	1853	1e65	1884	1890	1903	1906	1909	1983	2022
		2025	2081	2084	2191	2235	2985	3031	3034	3052	3602	3607	3628
		4529											
Z7B	007B	651	867	966	1085	1127	1152	1213	1241	1264	1292	1305	1332
		1343	1737	1e24	1830	1846	1866	1885	1891	1985	2024	2083	2192
		2983	3029	3037	3054	3603	3612	3629					

End, Part One

```

1      .L
2      .H
3 ;CBM-64-Part Two
4 ;
5 ;
0000   6 Z00    =  $00      ;6510 data direction register
0001   7 Z01    =  $01      ;6510 I/O register
8 ;      bit 0 (output) 0 = RAM at $A000-$BFFF (BASIC area)
9 ;      bit 1 (output) 0 = RAM at $E000-$EFFF (Kernal area)
10;     bit 2 (output) 0 = access CRT shapes at $D000-$DFFF
11;     bit 3 (output) cassette write line
12;     bit 4 (input)  cassette sense line
13;     bit 5 (output) cassette motor control
14;     bit 6 unused
15;     bit 7 unused
0002  16 Z02    =  $02      ;dummy address for offset
0003  17 Z03    =  $03      ;fixed-float vector
0004  18 Z04    =  $04      ;high byte of same
0005  19 Z05    =  $05      ;fixed/float vector
0006  20 Z06    =  $06      ;high byte of same
0007  21 Z07    =  $07      ;search character
000A  22 Z0A    =  $0A      ;0=load, 1=verify
0012  23 Z12    =  $12      ;sign flag
0013  24 Z13    =  $13      ;CMD file number
0016  25 Z16    =  $16      ;pointer into temporary string stack
0018  26 Z18    =  $18      ;high byte of last temp string vector
0022  27 Z22    =  $22      ;utility pointer area
0023  28 Z23    =  $23      ;
002B  29 Z2B    =  $2B      ;pointer to start of BASIC
002C  30 Z2C    =  $2C      ;high byte of same
002D  31 Z2D    =  $2D      ;pointer start of variables
002E  32 Z2E    =  $2E      ;high byte of same
0033  33 Z33    =  $33      ;pointer to start of string storage
0034  34 Z34    =  $34      ;high byte of same
0037  35 Z37    =  $37      ;pointer to limit of memory
0038  36 Z38    =  $38      ;high byte of same
0049  37 Z49    =  $49      ;file/device save area
004A  38 Z4A    =  $4A      ;second file/device save area
004E  39 Z4E    =  $4E      ;misc. work area
0053  40 Z53    =  $53      ;default step value
0054  41 Z54    =  $54      ;JMP vector for functions
0056  42 Z56    =  $56      ;
0057  43 Z57    =  $57      ;misc. numeric work area
005C  44 Z5C    =  $5C      ;
0061  45 Z61    =  $61      ;floating point accu # 1 - exponent
0062  46 Z62    =  $62      ;flp # 1 - mantissa
0063  47 Z63    =  $63      ;
0064  48 Z64    =  $64      ;
0065  49 Z65    =  $65      ;
0066  50 Z66    =  $66      ;fip # 1 - sign
0067  51 Z67    =  $67      ;series evaluation constant pointer
0068  52 Z68    =  $68      ;fip accu # 1 overflow
0069  53 Z69    =  $69      ;fip accu # 2 thru Z6E
006E  54 Z6E    =  $6E      ;
006F  55 Z6F    =  $6F      ;sign comparison fip accu #1 vs accu # 2
0070  56 Z70    =  $70      ;fip accu # 1 guard byte
0071  57 Z71    =  $71      ;table pointer for EXP/SIN/ATN
0072  58 Z72    =  $72      ;high byte of same
0073  59 Z73    =  $73      ;character fetch code, beginning address

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007A	60 Z7A	=	\$7A	;current character address
007B	61 Z7B	=	\$7B	;high byte of same
008B	62 Z8B	=	\$8B	;RND seed value
0090	63 Z90	=	\$90	;status word ST
0091	64 Z91	=	\$91	;keyboard scan results
0092	65 Z92	=	\$92	;tape timing speed correction
0093	66 Z93	=	\$93	;load=0, verify=1
0094	67 Z94	=	\$94	;serial output deferred character flag
0095	68 Z95	=	\$95	;serial deferred character
0096	69 Z96	=	\$96	;tape sync established flag
0097	70 Z97	=	\$97	;register save area
0098	71 Z98	=	\$98	;number of files open
0099	72 Z99	=	\$99	;input device
009A	73 Z9A	=	\$9A	;output device
009B	74 Z9B	=	\$9B	;tape character parity
009C	75 Z9C	=	\$9C	;tape byte available flag
009D	76 Z9D	=	\$9D	;direct/run mode (80/00)
009E	77 Z9E	=	\$9E	;tape pass 1 error log/char buffer
009F	78 Z9F	=	\$9F	;tape pass 2 error log
00A0	79 ZAO	=	\$AO	;jiffy clock - high byte
00A1	80 ZA1	=	\$A1	;jiffy clock - middle byte
00A2	81 ZA2	=	\$A2	;jiffy clock - low byte
00A3	82 ZA3	=	\$A3	;serial bit count/EOI flag
00A4	83 ZA4	=	\$A4	;serial byte read/tape cycle count
00A5	84 ZA5	=	\$A5	;serial bit count/tape hdr block count
00A6	85 ZA6	=	\$A6	;tape buffer pointer
00A7	86 ZA7	=	\$A7	;tape leader count/RS-232 input bit
00A8	87 ZA8	=	\$A8	;tape write new byte/read error/bit count
00A9	88 ZA9	=	\$A9	;tape write cycle/read error/start bit
00AA	89 ZAA	=	\$AA	;RS-232 input byte/tape scan/hdr count
00AB	90 ZAB	=	\$AB	;write leader length/read checksum/parity
00AC	91 ZAC	=	\$AC	;tape buffer/scrolling/I-O pointer
00AD	92 ZAD	=	\$AD	;high byte of same
00AE	93 ZAE	=	\$AE	;tape end address/end of I/O area
00AF	94 ZAF	=	\$AF	;high byte of same
00B0	95 ZB0	=	\$B0	;tape speed correction value
00B1	96 ZB1	=	\$B1	;work area for tape speed correction
00B2	97 ZB2	=	\$B2	;tape buffer pointer
00B3	98 ZB3	=	\$B3	;high byte of same
00B4	99 ZB4	=	\$B4	;RS-232 transmit bit count/tape sync
00B5	100 ZB5	=	\$B5	;RS-232 next bit to send/saved tape sync
00B6	101 ZB6	=	\$B6	;read char error/RS-232 output buffer
00B7	102 ZB7	=	\$B7	;number of characters in file name
00B8	103 ZB8	=	\$B8	;current logical file
00B9	104 ZB9	=	\$B9	;current secondary address
00BA	105 ZBA	=	\$BA	;current device
00BB	106 ZBB	=	\$BB	;pointer to file name
00BC	107 ZBC	=	\$BC	;high byte of same
00BD	108 ZBD	=	\$BD	;RS-232 xmit parity/tape read-write buffer
00BE	109 ZBE	=	\$BE	;tape phase
00BF	110 ZBF	=	\$BF	;tape input byte buffer
00C0	111 ZC0	=	\$C0	;tape motor interlock
00C1	112 ZC1	=	\$C1	;I/O start address/work address
00C2	113 ZC2	=	\$C2	;high byte of same
00C3	114 ZC3	=	\$C3	;kernal setup pointer
00C4	115 ZC4	=	\$C4	;high byte of same
00C5	116 ZC5	=	\$C5	;last key pressed
00C6	117 ZC6	=	\$C6	;keyboard buffer count
00C7	118 ZC7	=	\$C7	;reverse video switch
00C8	119 ZC8	=	\$C8	;end of line pointer for input

00C9	120 ZC9	=	\$C9	;input cursor, line number
00CA	121 ZCA	=	\$CA	;input cursor, position on line
00CB	122 ZCB	=	\$CB	;key pressed - \$40 if no key
00CC	123 ZCC	=	\$CC	;cursor enable - 0 = flash
00CD	124 ZCD	=	\$CD	;cursor flash timing countdown
00CE	125 ZCE	=	\$CE	;character under cursor
00CF	126 ZCF	=	\$CF	;cursor blink phase
00D0	127 ZDO	=	\$D0	;screen-kbd flag/screen line length
00D1	128 ZD1	=	\$D1	;pointer to screen line
00D2	129 ZD2	=	\$D2	;high byte of same
00D3	130 ZD3	=	\$D3	;position of cursor on line
00D4	131 ZD4	=	\$D4	;string flag
00D5	132 ZD5	=	\$D5	;screen line length current line
00D6	133 ZD6	=	\$D6	;cursor line number
00D7	134 ZD7	=	\$D7	;character-bit buffer/checksum
00D8	135 ZD8	=	\$D8	:# of outstanding inserts
00D9	136 ZD9	=	\$D9	;screen line table thru \$F0
00DA	137 ZDA	=	\$DA	; " " " "
00F1	138 ZF1	=	\$F1	;dummy screen link
00F3	139 ZF3	=	\$F3	;color memory pointer
00F4	140 ZF4	=	\$F4	;high byte of same
00F5	141 ZF5	=	\$F5	;keyboard table address
00F6	142 ZF6	=	\$F6	;high byte of same
00F7	143 ZF7	=	\$F7	;RS-232 receive buffer base address
00F8	144 ZF8	=	\$F8	;high byte of same
00F9	145 ZF9	=	\$F9	;RS-232 transmit buffer base address
00FA	146 ZFA	=	\$FA	;high byte of same

0014	148 X0014 =	\$0014	;integer value (SYS address)
0079	149 X0079 =	\$0079	;fetch current character
0100	150 X0100 =	\$0100	;flp to ASCII work area/tape error log
01FC	151 X01FC =	\$01FC	;prefix to line in input buffer
01FD	152 X01FD =	\$01FD	;high byte of same
0200	153 X0200 =	\$0200	;BASIC input buffer
0259	154 X0259 =	\$0259	;logical file table
0263	155 X0263 =	\$0263	;device # table
026D	156 X026D =	\$026D	;secondary address table
0277	157 X0277 =	\$0277	;keyboard buffer
0281	158 X0281 =	\$0281	;start of memory for operating system
0282	159 X0282 =	\$0282	;high byte of same
0283	160 X0283 =	\$0283	;top of memory for operating system
0284	161 X0284 =	\$0284	;high byte of same
0285	162 X0285 =	\$0285	;serial bus timeout flag (not used)
0286	163 X0286 =	\$0286	;current color code
0287	164 X0287 =	\$0287	;color under cursor
0288	165 X0288 =	\$0288	;screen memory page
0289	166 X0289 =	\$0289	;maximum size of keyboard buffer (10)
028A	167 X028A =	\$028A	;key repeat flag (\$8X=repeat all keys)
028B	168 X028B =	\$028B	;repeat key frequency counter
028C	169 X028C =	\$028C	;repeat key delay counter
028D	170 X028D =	\$028D	;keyboard shift/control flag
028E	171 X028E =	\$028E	;last keyboard shift pattern
028F	172 X028F =	\$028F	;address of keyboard decode routine
0290	173 X0290 =	\$0290	;high byte of same
0291	174 X0291 =	\$0291	;shift mode switch (\$80=locked)
0292	175 X0292 =	\$0292	;auto scroll flag (\$00=on)
0293	176 X0293 =	\$0293	;RS-232 Control Register
0294	177 X0294 =	\$0294	;RS-232 Command Register
0295	178 X0295 =	\$0295	;non-standard bit time
0296	179 X0296 =	\$0296	;high byte of same
0297	180 X0297 =	\$0297	;RS-232 Status Register
0298	181 X0298 =	\$0298	;number of bits to send/receive
0299	182 X0299 =	\$0299	;baud rate
029A	183 X029A =	\$029A	;high byte of same
029B	184 X029B =	\$029B	;RS-232 receive buffer input pointer
029C	185 X029C =	\$029C	;RS-232 receive buffer output pointer
029D	186 X029D =	\$029D	;RS-232 transmit buffer input pointer
029E	187 X029E =	\$029E	;RS-232 transmit buffer output pointer
029F	188 X029F =	\$029F	;IRQ vector save area
02A0	189 X02A0 =	\$02A0	;high byte of same
02A1	190 X02A1 =	\$02A1	;internal ICR2 activity register
02A2	191 X02A2 =	\$02A2	;internal CRBL activity register
02A3	192 X02A3 =	\$02A3	;ICRL save area
02A4	193 X02A4 =	\$02A4	;CRAL save area
02A5	194 X02A5 =	\$02A5	;pos first 40 column line after cursor
02A6	195 X02A6 =	\$02A6	;US/Intl machine flag (\$00 = US)
0300	196 X0300 =	\$0300	;error message link
030C	197 X030C =	\$030C	;save area for A register
030D	198 X030D =	\$030D	;save area for X register
030E	199 X030E =	\$030E	;save area for Y register
030F	200 X030F =	\$030F	;save area for SR (flag) register
0310	201 X0310 =	\$0310	;USR jump link
0311	202 X0311 =	\$0311	;low byte of USR jump address
0312	203 X0312 =	\$0312	;high byte of USR jump address
0314	204 X0314 =	\$0314	;IRQ vector
0315	205 X0315 =	\$0315	;high byte if IRQ vector
0316	206 X0316 =	\$0316	;BRK vector
0318	207 X0318 =	\$0318	;NMI vector

031A	208 X031A =	\$031A	;OPEN vector
031C	209 X031C =	\$031C	;CLOSE vector
031E	210 X031E =	\$031E	;set input vector
0320	211 X0320 =	\$0320	;set output vector
0322	212 X0322 =	\$0322	;restore I/O devices to default vector
0324	213 X0324 =	\$0324	;input vector
0326	214 X0326 =	\$0326	;output vector
0328	215 X0328 =	\$0328	;test STOP Key vector
032A	216 X032A =	\$032A	;GET vector
032C	217 X032C =	\$032C	;close all files and channels vector
0330	218 X0330 =	\$0330	;load RAM vector
0332	219 X0332 =	\$0332	;save RAM vector

8000	221 X8000 =	\$8000	;cartridge RESET vector
8002	222 X8002 =	\$8002	;cartridge RESTORE (warm start) vector
8004	223 X8004 =	\$8004	;cartridge identifier
A000	224 XA000 =	\$A000	;begin BASIC vector
A002	225 XA002 =	\$A002	;BASIC warm start vector
A364	226 TA364 =	\$A364	;message OK
A376	227 TA376 =	\$A376	;message READY
A408	228 XA408 =	\$A408	;array area overflow check
A437	229 XA437 =	\$A437	;error message link
A43A	230 XA43A =	\$A43A	;print error message
A474	231 XA474 =	\$A474	;print READY, do warm start
A483	232 WA483 =	\$A483	;standard BASIC warm start
A52A	233 XA52A =	\$A52A	;reset program ptrs and relink BASIC
A533	234 XA533 =	\$A533	;relink BASIC
A57C	235 WA57C =	\$A57C	;crunch tokens
A644	236 XA644 =	\$A644	;perform NEW
A663	237 XA663 =	\$A663	;perform CLR
A677	238 XA677 =	\$A677	;perform RESTORE, reset stack/pgm ptrs
A67A	239 XA67A =	\$A67A	;reset stack and program pointers
A68E	240 XA68E =	\$A68E	;re-initialize current character ptr
A71A	241 WA71A =	\$A71A	;print tokens
A7E4	242 WA7E4 =	\$A7E4	;execute a statement
AB1E	243 XAB1E =	\$AB1E	;print string from AY
AD8A	244 XAD8A =	\$AD8A	;get next non-string value
AD9E	245 XAD9E =	\$AD9E	;evaluate expression
AE86	246 WAE86 =	\$AE86	;fetch arithmetic element
AEFD	247 XAEFD =	\$AEFD	;check next character for ","
AF08	248 XAFO8 =	\$AFO8	;print SYNTAX Error
B1AA	249 WB1AA =	\$B1AA	;flop-fixed routine
B248	250 WB248 =	\$B248	;print ILLEGAL QUANTITY Error
B391	251 WB391 =	\$B391	;fixed-flop routine
B6A3	252 XB6A3 =	\$B6A3	;de-allocate temporary string storage
B79E	253 XB79E =	\$B79E	;fetch integer value in X, check range
B7F7	254 XB7F7 =	\$B7F7	;convert flop to integer
B849	255 XB849 =	\$B849	;half round flop accu
B850	256 XB850 =	\$B850	;subtract flop accu from # indexed by AY
B853	257 XB853 =	\$B853	;perform diadic minus
B867	258 XB867 =	\$B867	;add flop accu to # indexed by AY
B8D7	259 XB8D7 =	\$B8D7	;perform postshift
B9BC	260 TB9BC =	\$B9BC	;flop literal 1
BA28	261 XBA28 =	\$BA28	;multiply flop accu times # indexed by AY
BAB9	262 XBAB9 =	\$BAB9	;add exponents
BAD4	263 XBAD4 =	\$BAD4	;check sign of flop accu
BB07	264 XBB07 =	\$BB07	;divide flop accu by # indexed by AY
BBOF	265 XBB0F =	\$BBOF	;divide # indexed by AY by flop accu
BBA2	266 XBBAA2 =	\$BBA2	;load flop accu with # indexed by AY
BBC7	267 XBBC7 =	\$BBC7	;store flop accu at Z5C-60
BCA	268 XBBCA =	\$BBCA	;store flop accu at Z57-5B
BBD4	269 XBB04 =	\$BB04	;store flop accu in area indexed by XY
BCOC	270 XBCOC =	\$BCOC	;move rounded flop accu into 2nd flop accu
BCOF	271 XBCOF =	\$BCOF	;move flop accu into 2nd flop accu
BC2B	272 XBC2B =	\$BC2B	;get sign of flop accu into A
BCCC	273 XBCCC =	\$BCCC	;perform INT
EDCD	274 XBCDC =	\$BCDC	;print # from AX
BFB4	275 XBF04 =	\$BF04	;minus operator
BFC4	276 TBFC4 =	\$BFC4	;polynome table for EXP

```

278 ;6567 video chip
279 ;
D000 280 XDO000 = $D000      ;6567 video chip base address
D011 281 XDO011 = $D011      ;bit 4 = 0 to disable video chip
D012 282 XDO012 = $D012      ;Raster Register
D016 283 XDO016 = $D016      ;bit 5 = 0 to reset video chip
D018 284 XDO018 = $D018      ;memory pointers for video chip
D019 285 XDO019 = $D019      ;Interrupt Register
D021 286 XDO021 = $D021      ;Background # 0 color
287 ;
288 ;6581 Sound Interface Device
289 ;
D418 290 XDO418 = $D418      ;mode/volume for SID chip
291 ;
292 ;6526 CIA1
293 ;
DC00 294 XDC00 = $DC00      ;PAL port A
DC01 295 XDC01 = $DC01      ;PBI port B
DC02 296 XDC02 = $DC02      ;DDRAl direction bits for port A
DC03 297 XDC03 = $DC03      ;DDRBl direction bits for port B
DC04 298 XDC04 = $DC04      ;TAL1 timer A low
DC05 299 XDC05 = $DC05      ;TAH1 timer A high
DC06 300 XDC06 = $DC06      ;TBL1 timer B low
DC07 301 XDC07 = $DC07      ;TBH1 timer B high
DC0D 302 XDC0D = $DC0D      ;ICR1 interrupt control register
DC0E 303 XDC0E = $DC0E      ;CRA1 control register for port A
DC0F 304 XDC0F = $DC0F      ;CRB1 control register for port B
305 ;
306 ;6526 CIA2
307 ;
DD00 308 XDD00 = $DD00      ;PA2 port A
DD01 309 XDD01 = $DD01      ;PB2 port B
DD02 310 XDD02 = $DD02      ;DDR2A direction bits for port A
DD03 311 XDD03 = $DD03      ;DDR2B direction bits for port B
DD04 312 XDD04 = $DD04      ;TAL2 timer A low
DD05 313 XDD05 = $DD05      ;TAH2 timer A high
DD06 314 XDD06 = $DD06      ;TBL2 timer B low
DD07 315 XDD07 = $DD07      ;TBH2 timer B high
DD0D 316 XDD0D = $DD0D      ;ICR2 interrupt control register
DD0E 317 XDD0E = $DD0E      ;CRA2 control register for port A
DD0F 318 XDD0F = $DD0F      ;CRB2 control register for port B

```

```

320 ;continuation of "EXP" routine
321 ;
E000      322     .OR $E000
E000 8556  323     STA Z56      ;set guard byte for second flp accu
E002 200FBC 324     JSR XBCOF   ;copy flp accu into second flp accu
E005 A561   325     LDA Z61      ;get exponent
E007 C988   326     CMP $88     ;if => 8
E009 9003   327     BCC BE00E
E00B 20D4BA 328     BE00B JSR XBAD4 ;then either 0 or overflow
E00E 20CCBC 329     BE00E JSR XBCCC ;perform INT
E011 A507   330     LDA Z07      ;get least significant byte
E013 18    331     CLC
E014 6981   332     ADC $81     ;if = 127
E016 F0F3   333     BEQ BE00B   ;then also overflow
E018 38    334     SEC
E019 E901   335     SBC $01     ;remove excess 128
E01B 48    336     PHA         ;and save it
E01C A205   337     LDX $05
E01E B569   338     BE01E LDA Z69,X ;move second flp accu into flp accu
E020 B461   339     LDY Z61,X   ;and vice versa
E022 9561   340     STA Z61,X
E024 9469   341     STY Z69,X
E026 CA    342     DEX
E027 10F5   343     BPL BE01E
E029 A556   344     LDA Z56
E02B 8570   345     STA Z70      ;restore copied guard byte
E02D 2053B8 346     JSR XB853   ;apply diadic "-"
E030 20B4BF 347     JSR XBF84   ;then minus operator
E033 A9C4   348     LDA <TBFC4
E035 A0BF   349     LDY >TBFC4 ;set AY to polynome table
E037 2059E0 350     JSR SE059   ;and compute polynome
E03A A900   351     LDA $00
E03C 856F   352     STA Z6F      ;clear XOR of signs
E03E 68    353     PLA         ;add saved integral part
E03F 20B9BA 354     JSR XBAB9   ;to exponent
E042 60    355     RTS

```

```

357 ;compute odd degrees for SIN and ATN
358 ;
E043 8571 359 JE043 STA Z71      ;save table pointer
E045 8472 360 STY Z72
E047 20CABB 361 JSR XBBCA    ;store flp accu at Z57
E04A A957 362 LDA <Z57    ;set AY to Z57
E04C 2028BA 363 JSR XBA28    ;multiply flp accu by # indexed by AY
E04F 205DDEO 364 JSR SE05D    ;compute polynome
E052 A957 365 LDA <Z57    ;set AY to Z57
E054 A000 366 LDY >Z57
E056 4C28BA 367 JMP XBA28    ;multiply flp accu by Z57
368 ;
369 ;compute polynome according to table indexed by AY
370 ;
E059 8571 371 SE059 STA Z71      ;save table pointer
E05B 8472 372 STY Z72
E05D 20C7BB 373 SE05D JSR XBBC7    ;store flp accu at Z5C
E060 B171 374 LDA (Z71),Y
E062 8567 375 STA Z67    ;save order
E064 A471 376 LDY Z71
E066 C8   377 INY      ;add 1 to table pointer
E067 98   378 TYA
E068 D002 379 BNE BE06C
E06A E672 380 INC Z72
E06C 8571 381 BE06C STA Z71      ;save updated pointer
E06E A472 382 LDY Z72    ;and restore AY
E070 2028BA 383 BE070 JSR XBA28    ;multiply flp accu by # indexed by AY
E073 A571 384 LDA Z71    ;restore AY
E075 A472 385 LDY Z72
E077 18   386 CLC
E078 6905 387 ADC $05    ;add 5 to table pointer
E07A 9001 388 BCC BE07D
E07C C8   389 INY
E07D 8571 390 BE07D STA Z71      ;save table pointer
E07F 8472 391 STY Z72
E081 2067BB 392 JSR XB867    ;add # indexed by AY to flp accu
E084 A95C 393 LDA <Z5C
E086 A000 394 LDY >Z5C    ;set AY to Z5C
E088 C667 395 DEC Z67    ;decrement order
E08A D0E4 396 BNE BE070    ;and repeat until 0
E08C 60   397 RTS

```

```

399 ;floating point numbers for RND
400 ;
401 ; flp number for multiplication
E08D 983544 402 TEO8D .BY $98,$35,$44,$7A,$00
403 ; flp number for addition
E092 6828B1 404 TE092 .BY $68,$28,$B1,$46,$00
405 ;
406 ;"RND" command
407 ;
E097 202BBC 408 WE097 JSR XBC2B      ;get sign of flp accu into A
E09A 3037    409 BMI BE0D3      ;if < 0 use parameter as seed
E09C D020    410 BNE BE0BE      ;if > 0 use old seed
E09E 20F3FF  411 JSR SFFF3      ;get base address of I/O devices
EOA1 8622    412 STX Z22
EOA3 8423    413 STY Z23
EOA5 A004    414 LDY $04
EOA7 B122    415 LDA (Z22),Y   ;TAL1 timer value
EOA9 8562    416 STA Z62
EOAB C8     417 INY
EOAC B122    418 LDA (Z22),Y   ;TAH2 timer value
EOAE 8564    419 STA Z64
EOBO A008    420 LDY $08
EOB2 B122    421 LDA (Z22),Y   ;tenths of a second
EOB4 8563    422 STA Z63
EOB6 C8     423 INY
EOB7 B122    424 LDA (Z22),Y   ;seconds
EOB9 8565    425 STA Z65
EOBB 4CE3EO  426 JMP JEOE3      ;garble flp set from CIA1 timer/clock
427 ;
EOBE A98B    428 BE0BE LDA <Z8B      ;let AY point to Z8B (current seed)
EOCO A000    429 LDY >Z8B
EOC2 20A2BB  430 JSR XBBA2      ;load flp accu from Z8B-Z8F
EOC5 A98D    431 LDA <TE08D      ;set AY to RND factor
EOC7 A0E0    432 LDY >TE08D
EOC9 2028BA  433 JSR XBA28      ;multiply flp accu times RND factor
EOCC A992    434 LDA <TE092      ;set AY to RND addition value
EOCE AOE0    435 LDY >TE092
EODO 2067B8  436 JSR XB867      ;add RND factor to result in flp accu
EOD3 A665    437 BE0D3 LDX Z65      ;exchange byte 4 and byte 1
EOD5 A562    438 LDA Z62
EOD7 8565    439 STA Z65
EOD9 8662    440 STX Z62
EODB A663    441 LDX Z63      ;exchange byte 2 and byte 3
EODD A564    442 LDA Z64
EODF 8563    443 STA Z63
EOE1 8664    444 STX Z64
EOE3 A900    445 JEOE3 LDA $00      ;set sign positive
EOE5 8566    446 STA Z66
EOE7 A561    447 LDA Z61
EOE9 8570    448 STA Z70      ;set guard byte
EOEB A980    449 LDA $80      ;move 0 to exponent
EOED 8561    450 STA Z61
EOEF 20D7B8  451 JSR XB8D7      ;perform postshift
EOF2 A28B    452 LDX <Z8B      ;set XY to RND seed value
EOF4 A000    453 LDY >Z8B
EOF6 4CD4BB  454 SE0F6 JMP XBBBD4  ;store flp accu as new seed

```

```

        456 ;handle errors for direct I/O calles from BASIC interpreter
457 ;
EOF9 C9F0 458 BEOF9 CMP $F0      ;if open for RS-232,
EOFB D007 459     BNE BE104
EOFD 8438 460     STY Z38       ;set new top of memory limit
EOFF 8637 461     STX Z37
E101 4C63A6 462     JMP XA663   ;CLR, back to basic
463 ;
E104 AA    464 BE104 TAX
E105 D002 465     BNE BE109   ;if no error message indexed,
E107 A21E 466     LDX $1E      ;select BREAK message
E109 4C37A4 467 BE109 JMP XA437 ;go print message
468 ;
E10C 20D2FF 469     JSR SFFD2  ;output a character
E10F BOE8   470     BCS BEOF9 ;if no errors,
E111 60    471     RTS       ;return
472 ;
E112 20CFFF 473     JSR SFFCF  ;input a character on current device
E115 BOE2   474     BCS BEOF9 ;if no errors,
E117 60    475     RTS       ;return
476 ;
E118 20ADE4 477     JSR SE4AD  ;set output device
E11B B0DC   478     BCS BEOF9 ;if no errors,
E11D 60    479     RTS       ;return
480 ;
E11E 20C6FF 481     JSR SFFC6  ;set input device
E121 B0D6   482     BCS BEOF9 ;if no errors,
E123 60    483     RTS       ;return
484 ;
E124 20E4FF 485     JSR SFFE4  ;get a character from current device
E127 B0D0   486     BCS BEOF9 ;if no errors,
E129 60    487     RTS       ;return

```

```

489 ;"SYS" command
490 ;
E12A 208AAD 491 WE12A JSR XAD8A ;get next non-string value
E12D 20F7B7 492 JSR XB7F7 ;convert to integer in Z14/15
E130 A9E1 493 LDA >WE147-1
E132 48 494 PHA
E133 A946 495 LDA <WE147-1
E135 48 496 PHA ;set return address
E136 ADOFO3 497 LDA X030F
E139 48 498 PHA ;save flag register on stack
E13A ADOC03 499 LDA X030C
E13D AEOD03 500 LDX X030D ;restore A, X & Y
E140 ACOE03 501 LDY X030E ;to status of exit from last SYS
E143 28 502 PLP
E144 6C1400 503 JMP (X0014) ;do SYS routine
      504 ;
E147 08 505 WE147 PHP ;save flag register on stack
E148 8DOC03 506 STA X030C ;save A
E14B 8EOD03 507 STX X030D ;save X
E14E 8COE03 508 STY X030E ;save Y
E151 68 509 PLA
E152 8DOFO3 510 STA X030F ;save Flag register
E155 60 511 RTS

```

```

      513 ;"SAVE" command
      514 ;
E156 20D4E1 515 WE156 JSR SE1D4 ;set file parameters
E159 A62D 516 LDX Z2D ;set end address of BASIC text
E15B A42E 517 LDY Z2E
E15D A928 518 LDA <Z2B ;set address of start address
E15F 20D8FF 519 JSR SFFD8 ;save RAM to a device
E162 B095 520 BCS BE0F9 ;if no errors,
E164 60     521 RTS ;return
      522 ;
      523 ;"VERIFY" command
      524 ;
E165 A901 525 WE165 LDA $01 ;set value for Verify
E167 2C     526 .BY $2C ;skip next instruction
      527 ;
      528 ;"LOAD" command
      529 ;
E168 A900 530 WE168 LDA $00 ;set value for Load
E16A 850A 531 STA ZOA ;set load/verify flag
E16C 20D4E1 532 JSR SE1D4 ;fetch file parameters
E16F A50A 533 LDA ZOA ;fetch load/verify flag
E171 A62B 534 LDX Z2B ;set start address in XY
E173 A42C 535 LDY Z2C
E175 20D5FF 536 JSR SFFD5 ;load device to RAM
E178 B057 537 BCS BE1D1 ;exit upon error
E17A A50A 538 LDA ZOA
E17C F017 539 BEQ BE195 ;if verify pass,
E17E A21C 540 LDX $1C ;index Verify Error message
E180 20B7FF 541 JSR SFFB7 ;read ST
E183 2910 542 AND $10 ;if ST indicates a mismatch,
E185 D017 543 BNE BE19E ;go print error
E187 A57A 544 LDA Z7A
E189 C902 545 CMP $02
E18B F007 546 BEQ BE194 ;exit if in RUN mode, else
E18D A964 547 LDA <TA364 ;set AY to point to message OK
E18F A0A3 548 LDY >TA364
E191 4C1EAB 549 JMP XAB1E ;print message OK
E194 60     550 BE194 RTS
      551 ;
E195 20B7FF 552 BE195 JSR SFFB7 ;if load pass
E198 29BF 553 AND $BF ;and ST indicates an error
E19A F005 554 BEQ BE1A1
E19C A21D 555 LDX $1D ;index Load Error message
E19E 4C37A4 556 BE19E JMP XA437 ;print message
      557 ;
E1A1 A57B 558 BE1A1 LDA Z7B ;check high addr of current character
E1A3 C902 559 CMP $02
E1A5 D00E 560 BNE BE1B5 ;if in direct mode
E1A7 862D 561 STX Z2D ;move end of program address
E1A9 842E 562 STY Z2E ;to end of BASIC address
E1AB A976 563 LDA <TA376 ;set AY to READY message
E1AD A0A3 564 LDY >TA376
E1AF 201EAB 565 JSR XAB1E ;print READY
E1B2 4C2AA5 566 JMP XA52A ;relink BASIC, exit
      567 ;
      568 ;end of load/verify from within a program
      569 ;
E1B5 208EA6 570 BE1B5 JSR XA68E ;move start of program to next char addr
E1B8 2033A5 571 JSR XA533 ;relink BASIC
E1BB 4C77A6 572 JMP XA677 ;restore, clear pointers, return

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      574 ;"OPEN" command
      575 ;
E1BE 2019E2 576 WE1BE JSR SE219 ;fetch parameters
E1C1 20COFF 577 JSR SFFCO ;perform open
E1C4 B00B   578 BCS BE1D1 ;if no errors,
E1C6 60     579 RTS ;return
      580 ;
      581 ;"CLOSE" command
      582 ;
E1C7 2019E2 583 WE1C7 JSR SE219 ;fetch parameters
E1CA A549   584 LDA Z49 ;restore file #
E1CC 20C3FF 585 JSR SFFC3 ;perform close
E1CF 90C3   586 BCC BE194 ;exit if no errors
E1D1 4CF9EO 587 BE1D1 JMP BE0F9 ;error
      588 ;
      589 ;set parameters for load/verify/save
      590 ;
E1D4 A900   591 SE1D4 LDA $00 ;assume no file name
E1D6 20BDFF 592 JSR SFFBD ;set file name parameters
E1D9 A201   593 LDX $01 ;assume device 1
E1DB A000   594 LDY $00 ;and secondary address 0
E1DD 20BAFF 595 JSR SFFBA ;set logical file, device & sec. addr
E1E0 2006E2 596 JSR SE206 ;fetch current character
E1E3 2057E2 597 JSR SE257 ;evaluate expression
E1E6 2006E2 598 JSR SE206 ;fetch current character
E1E9 2000E2 599 JSR SE200 ;skip comma and fetch integer into X
E1EC A000   600 LDY $00 ;secondary address still 0
E1EE 8649   601 STX Z49 ;save device #
E1FO 20BAFF 602 JSR SFFBA ;set logical file, device & sec. addr
E1F3 2006E2 603 JSR SE206 ;fetch current character
E1F6 2000E2 604 JSR SE200 ;skip comma and fetch integer into X
E1F9 8A     605 TXA
E1FA A8     606 TAY ;set secondary address
E1FB A649   607 LDX Z49 ;restore device .
E1FD 4CBAFF 608 JMP SFFBA ;set logical file, device & sec. addr
      609 ;
      610 ;skip comma and fetch integer into X
      611 ;
E200 200EE2 612 SE200 JSR SE20E ;check for and skip comma
E203 4C9EB7 613 JMP XB79E ;fetch integer value into X
      614 ;
      615 ;fetch current character and check for end of line
      616 ;
E206 207900 617 SE206 JSR X0079 ;fetch current character
E209 D002   618 BNE BE20D
E20B 68     619 PLA ;if end of line, delete own return addr
E20C 68     620 PLA
E20D 60     621 BE20D RTS
      622 ;
      623 ;check for a comma and skip it
      624 ;
E20E 20FDAE 625 SE20E JSR XAEFD ;check for and skip ","
E211 207900 626 SE211 JSR X0079 ;fetch current character
E214 DOF7   627 BNE BE20D
E216 4C08AF 628 JMP XAF08 ;SYNTAX Error if end of line reached

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```

630 ;get Open/Close parameters
631 ;
E219 A900 632 SE219 LDA $00      ;assume no file name
E21B 20BDFF 633 JSR SFFBD     ;set file name parameters
E21E 2011E2 634 JSR SE211     ;fetch current character
E221 209EB7 635 JSR XB79E    ;get next non-string value into X
E224 8649 636 STX Z49       ;save file number
E226 8A   637 TXA
E227 A201 638 LDX $01       ;assume device 1
E229 A000 639 LDY $00       ;and secondary address 0
E22B 20BAFF 640 JSR SFFBA     ;set currrent file, device & sec. addr
E22E 2006E2 641 JSR SE206     ;fetch current character
E231 2000E2 642 JSR SE200     ;skip comma and fetch integer value into X
E234 864A 643 STX Z4A       ;save device number
E236 A000 644 LDY $00       ;secondary still 0
E238 A549 645 LDA Z49
E23A E003 646 CPX $03
E23C 9001 647 BCC BE23F     ;if device number > 3
E23E 88   648 DEY          ;secondary = $FF
E23F 20BAFF 649 BE23F JSR SFFBA    ;set logical file, device & sec. addr
E242 2006E2 650 JSR SE206     ;fetch current character
E245 2000E2 651 JSR SE200     ;skip comma,]fetch integer value in X
E248 8A   652 TXA
E249 A8   653 TAY          ;set secondary address
E24A A64A 654 LDX Z4A       ;restore device
E24C A549 655 LDA Z49       ;and file
E24E 20BAFF 656 JSR SFFBA     ;set logical file, device & sec. addr
E251 2006E2 657 JSR SE206     ;fetch current character
E254 200EE2 658 JSR SE20E     ;check for and skip ","
E257 209EAD 659 SE257 JSR XAD9E    ;evaluate expression
E25A 20A3B6 660 JSR XB6A3     ;de-allocate temporary string
E25D A622 661 LDX Z22
E25F A423 662 LDY Z23       ;XY = address of file name
E261 4CBDFF 663 JMP SFFBD     ;set file name parameters

```

```

665 ;"COS" command
666 ;
E264 A9E0 667 WE264 LDA <TE2E0 ;set AY to point to 0.5 * PI
E266 AOE2 668 LDY >TE2E0
E268 2067B8 669 JSR XB867 ;add to flp accu then do SIN
670 ;
671 ;"SIN" command
672 ;
E26B 200CBC 673 SE26B JSR XBCOC ;move rounded flp accu to 2nd flp accu
E26E A9E5 674 LDA <TE2E5 ;set AY to 2 * PI
E270 AOE2 675 LDY >TE2E5
E272 A66E 676 LDX Z6E ;get sign
E274 2007BB 677 JSR XBB07 ;divide flp accu by 2 * PI
E277 200CBC 678 JSR XBCOC ;move rounded flp accu to 2nd flp accu
E27A 20CCBC 679 JSR XBCCC ;call function INT
E27D A900 680 LDA $00
E27F 856F 681 STA Z6F ;set XOR of signs to be the same
E281 2053B8 682 JSR XB853 ;apply diadic operator "-"
E284 A9EA 683 LDA <TE2EA ;set AY to point to 0.25
E286 AOE2 684 LDY >TE2EA
E288 2050B8 685 JSR XB850 ;subtract flp accu from 0.25
E28B A566 686 LDA Z66 ;flp accu # 1 - sign
E28D 48 687 PHA ;save sign
E28E 100D 688 BPL BE29D ;if negative
E290 2049B8 689 JSR XB849 ;do half rounding (add 0.5)
E293 A566 690 LDA Z66 ;get sign
E295 3009 691 BMI BE2AO ;if positive, complement flag
E297 A512 692 LDA Z12
E299 49FF 693 EOR $FF
E29B 8512 694 STA Z12
E29D 20B4BF 695 BE29D JSR XFBF4 ;apply monadic operator "-"
E2A0 A9EA 696 BE2AO LDA <TE2EA ;set AY to 0.25
E2A2 AOE2 697 LDY >TE2EA
E2A4 2067B8 698 JSR XB867 ;add 0.25 to flp accu
E2A7 68 699 PLA ;restore original sign
E2A8 1003 700 BPL BE2AD ;if negative,
E2AA 20B4BF 701 JSR XFBF4 ;perform monadic "-" again
E2AD A9EF 702 BE2AD LDA <TE2EF ;set AY to polynome table
E2AF AOE2 703 LDY >TE2EF
E2B1 4C43EO 704 JMP JE043 ;go compute odd degrees

```

```

706 ;"TAN" command
707 ;
E2B4 20CABB 708 WE2B4 JSR XBBCA ;store flp accu at Z57-5B
E2B7 A900 709 LDA $00
E2B9 8512 710 STA Z12 ;clear sign flag
E2BB 206BE2 711 JSR SE26B ;perform SIN
E2BE A24E 712 LDX <Z4E ;set AY to Z4E
E2C0 A000 713 LDY >Z4E
E2C2 20F6E0 714 JSR SEOF6 ;store flp accu at Z4E
E2C5 A957 715 LDA <Z57 ;set AY to Z57
E2C7 A000 716 LDY >Z57
E2C9 20A2BB 717 JSR XBBA2 ;move flp accu there
E2CC A900 718 LDA $00
E2CE 8566 719 STA Z66 ;clear sign of flp accu
E2DO A512 720 LDA Z12 ;fetch sign flag
E2D2 20DCE2 721 JSR SE2DC ;compute COS of flp accu
E2D5 A94E 722 LDA <Z4E ;set AY to Z4E
E2D7 A000 723 LDY >Z4E
E2D9 4C0FB2 724 JMP XBB0F ;divide number at Z4E by flp accu, exit
725 ;
E2DC 48 726 SE2DC PHA
E2DD 4C9DE2 727 JMP BE29D ;compute COS of flp accu then return
728 ;
729 ;flp numbers for SIN, COS and TAN
730 ;
731 ;0.5 * PI
E2EO 81490F 732 TE2EO .BY $81,$49,$0F,$DA,$A2
733 ;2 * PI
E2E5 83490F 734 TE2E5 .BY $83,$49,$0F,$DA,$A2
735 ;0.25
E2EA 7F0000 736 TE2EA .BY $7F,$00,$00,$00,$00
737 ;
E2EF 05 738 TE2EF .BY $05 ;polynome table for SIN
739 ;-14.3813907
E2FO 84E61A 740 .BY $84,$E6,$1A,$2D,$1B
741 ; 42.0077971
E2F5 862807 742 .BY $86,$28,$07,$FB,$F8
743 ;-76.7041703
E2FA 879968 744 .BY $87,$99,$68,$89,$01
745 ; 81.6052237
E2FF 872335 746 .BY $87,$23,$35,$DF,$E1
747 ;-41.3417021
E304 86A55D 748 .BY $86,$A5,$5D,$E7,$28
749 ; 6.28318531
E309 83490F 750 .BY $83,$49,$0F,$DA,$A2

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```

752 ;"ATN" command
753 ;
E30E A566 754 WE30E LDA Z66      ;save sign
E310 48   755 PHA
E311 1003 756 BPL BE316      ;if negative,
E313 2084BF 757 JSR XBFB4      ;apply monadic operator "-"
E316 A561 758 BE316 LDA Z61
E318 48   759 PHA      ;save exponent
E319 C981 760 CMP $81      ;if => 1
E31B 9007 761 BCC BE324
E31D A9BC 762 LDA <TB9BC      ;let AY point to 1
E31F A0B9 763 LDY >TB9BC
E321 200FBB 764 JSR XBB0F      ;divide 1 by flp accu
E324 A93E 765 BE324 LDA <TE33E      ;set AY to polynome table for ATN
E326 AOE3 766 LDY >TE33E
E328 2043EO 767 JSR JE043      ;compute odd degrees
E32B 68   768 PLA
E32C C981 769 CMP $81      ;if exponent => 1
E32E 9007 770 BCC BE337
E330 A9E0 771 LDA <TE2E0      ;set AY to 0.5 * PI
E332 AOE2 772 LDY >TE2E0
E334 2050B8 773 JSR XB850      ;subtract flp accu from 0.5 * PI
E337 68   774 BE337 PLA
E338 1003 775 BPL BE33D      ;if sign negative
E33A 4CB4BF 776 JMP XBF4      ;apply monadic operator "-"
777 ;
E33D 60   778 BE33D RTS
779 ;
780 ;flp numbers for ATN
781 ;
E33E 0B   782 TE33E .BY $0B
783 ;-0.000684793912
E33F 76B383 784 .BY $76,$B3,$83,$BD,$D3
785 ; 0.00485094216
E344 791EF4 786 .BY $79,$1E,$F4,$A6,$F5
787 ;-0.0131117018
E349 7B83FC 788 .BY $7B,$83,$FC,$B0,$10
789 ; 0.034209638
E34E 7C0C1F 790 .BY $7C,$0C,$1F,$67,$CA
791 ;-0.0542791328
E353 7CDE53 792 .BY $7C,$DE,$53,$CB,$C1
793 ; 0.0724571965
E358 7D1464 794 .BY $7D,$14,$64,$70,$4C
795 ;-0.0898023954
E35D 7DB7EA 796 .BY $7D,$B7,$EA,$51,$7A
797 ; 0.110932413
E362 7D6330 798 .BY $7D,$63,$30,$88,$7E
799 ;-0.142839808
E367 7E9244 800 .BY $7E,$92,$44,$99,$3A
801 ; 0.19999912
E36C 7E4CCC 802 .BY $7E,$4C,$CC,$91,$C7
803 ;-0.333333316
E371 7FAAAA 804 .BY $7F,$AA,$AA,$AA,$13
805 ; 1
E376 810000 806 .BY $81,$00,$00,$00,$00

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```

808 ;warm start entry (stop/restore)
809 ;
E37B 20CCFF 810      JSR SFFCC    ;close all files, set default devices
E37E A900   811      LDA $00
E380 8513   812      STA Z13     ;clear CMD file number flag
E382 207AA6 813      JSR XA67A   ;reset pointers
E385 58    814      CLI        ;allow IRQ
E386 A280   815      BE386    LDX $80    ;index default message READY
E388 6C0003 816      JMP (X0300) ;print message (normally E38B)
817 ;
818 ;handle error messages
819 ;
E38B 8A    820      WE38B TXA
E38C 3003  821      BMI BE391   ;if X < $80
E38E 4C3AA4 822      JMP XA43A   ;print BASIC message
823 ;
E391 4C74A4 824      BE391 JMP XA474   ;else print READY message
825 ;
826 ;RESET routine
827 ;
E394 2053E4 828      JSR SE453    ;initialize O/S vectors
E397 20BFEE 829      JSR SE3BF    ;initialize BASIC interpreter
E39A 2022E4 830      JSR SE422    ;print BASIC start-up messages
E39D A2FB   831      LDX $FB
E39F 9A    832      TXS        ;initialize stack pointer
E3A0 DOE4   833      BNE BE386   ;print message READY
834 ;
835 ;character fetch code for page zero 0073-008F
836 ;
E3A2 E67A   837      TE3A2 INC Z7A    ;bump character pointer (low)
E3A4 D002   838      BNE BE3A8   ;if overflow,
E3A6 E67B   839      INC Z7B    ;bump character pointer (high)
E3A8 AD60EA 840      BE3A8 LDA BEA61-1 ;fetch character from modified address
E3AB C93A   841      CMP '9+1   ;if above numerics
E3AD B00A   842      BCS BE3B9   ;return with C = 1 (and Z = 1 if ":")
E3AF C920   843      CMP $20    ;if character is a space,
E3B1 FOEF   844      BEQ TE3A2   ;ignore and get next character
E3B3 38    845      SEC
E3B4 E930   846      SBC '0    ;if below numerics
E3B6 38    847      SEC
E3B7 E9D0   848      SBC $D0    ;return with C = 1 (and Z = 1 if $00)
E3B9 60    849      BE3B9 RTS    ;if numeric, return with C = 0
850 ;
851 ;first RND seed value
852 ;
E3BA 804FC7 853      .BY $80,$4F,$C7,$52,$58

```

```

855 ;initialization for BASIC interpreter
856 ;
E3BF A94C 857 SE3BF LDA $4C      ;set JMP instruction
E3C1 8554 858 STA Z54        ;for functions
E3C3 8D1003 859 STA X0310     ;and USR vector
E3C6 A948 860 LDA <WB248    ;default USR jump address
E3C8 A0B2 861 LDY >WB248    ;(ILLEGAL QUANTITY Error)
E3CA 8D1103 862 STA X0311     ;set USR jump address, low byte
E3CD 8C1203 863 STY X0312     ;USR jump address, high byte
E3D0 A991 864 LDA <WB391
E3D2 A0B3 865 LDY >WB391
E3D4 8505 866 STA Z05        ;set fixed-float vector
E3D6 8406 867 STY Z06        ;& high byte
E3D8 A9AA 868 LDA <WB1AA
E3DA A0B1 869 LDY >WB1AA
E3DC 8503 870 STA Z03        ;set float-fixed vector
E3DE 8404 871 STY Z04        ;& high byte
E3EO A21C 872 LDX $1C
E3E2 BDA2E3 873 BE3E2 LDA TE3A2,X ;move character fetch code to $73-8A
E3E5 9573 874 STA Z73,X     ;and first RND seed into Z8B-Z8F
E3E7 CA 875 DEX
E3E8 10F8 876 BPL BE3E2
E3EA A903 877 LDA $03
E3EC 8553 878 STA Z53        ;set default step
E3EE A900 879 LDA $00
E3FO 8568 880 STA Z68        ;clear flp accu overflow area
E3F2 8513 881 STA Z13        ;set CMD file number to default
E3F4 8518 882 STA Z18        ;clear high of string descriptor index
E3F6 A201 883 LDX $01
E3F8 8EFD01 884 STX X01FD
E3FB 8EFC01 885 STX X01FC     ;prefix input buffer with dummy pointer
E3FE A219 886 LDX $19
E400 8616 887 STX Z16        ;set pointer to temporary string stack
E402 38 888 SEC
E403 209cff 889 JSR SFF9C    ;read bottom of memory address
E406 862B 890 STX Z2B        ;to set BASIC bottom of memory
E408 842C 891 STY Z2C
E40A 38 892 SEC
E40B 2099FF 893 JSR SFF99    ;read top of memory address
E40E 8637 894 STX Z37        ;to set BASIC memory limit
E410 8438 895 STY Z38
E412 8633 896 STX Z33        ;set string storage address
E414 8434 897 STY Z34        ;& high byte
E416 A000 898 LDY $00
E418 98 899 TYA
E419 912B 900 STA (Z2B),Y   ;move a 0 to bottom of memory
E41B E62B 901 INC Z2B        ;add 1 to start of BASIC address
E41D D002 902 BNE BE421
E41F E62C 903 INC Z2C        ;& high byte upon overflow
E421 60 904 BE421 RTS

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```

906 ;print BASIC start-up messages
907 ;
E422 A52B 908 SE422 LDA Z2B      ;set AY to start of BASIC
E424 A42C 909 LDY Z2C
E426 2008A4 910 JSR XA408      ;perform array area overflow check
E429 A973 911 LDA <TE473      ;set AY to message COMMODORE 64 BASIC...
E42B AOE4 912 LDY >TE473
E42D 201EAB 913 JSR XABIE      ;print message
E430 A537 914 LDA Z37        ;use limit of memory
E432 38   915 SEC
E433 E52B 916 SBC Z2B      ;- pointer to start of BASIC
E435 AA   917 TAX
E436 A538 918 LDA Z38        ;& high bytes
E438 E52C 919 SBC Z2C      ;to calculate bytes free
E43A 20CDBD 920 JSR XBDCCD    ;convert to string
E43D A960 921 LDA <TE460      ;set AY to message BYTES FREE
E43F AOE4 922 LDY >TE460
E441 201EAB 923 JSR XABIE      ;print # then BYTES FREE
E444 4C44A6 924 JMP XA644      ;perform NEW, print READY
925 ;
926 ;vectors for $0300-$030B
927 ;
E447 8BE3 928 TE447 .W WE38B      ;error message vector
E449 83A4 929 .W WA483      ;warm start vector
E44B 7CA5 930 .W WA57C      ;crunch BASIC tokens vector
E44D 1AA7 931 .W WA71A      ;print tokens vector
E44F E4A7 932 .W WA7E4      ;execute a statement vector
E451 86AE 933 .W WAE86      ;get arithmetic element vector
934 ;
935 ;initialize vectors at $0300-$030B
936 ;
E453 A20B 937 SE453 LDX $0B
E455 BD47E4 938 BE455 LDA TE447,X      ;fetch a byte from table
E458 9D0003 939 STA X0300,X      ;and move it to vector area
E45B CA   940 DEX
E45C 10F7 941 BPL BE455      ;repeat until 6 vectors stored
E45E 60   942 RTS
943 ;
E45F 00   944 .BY $00
E460 204241 945 TE460 .BY 'B,'A,'S,'I,'C,' , 'B,'Y,'T,'E,'S,' , 'F,'R,'E,'E
E471 0D00 946 .BY $0D,$00
E473 930D20 947 TE473 .BY $93,$0D,' , ' , '
E479 2A2A2A 948 .BY '*,*,*,*,*, ', 'C,'O,'M,'M,'O,'D,'O,'R,'E
E487 203634 949 .BY ' , '6,'4,' , 'B,'A,'S,'I,'C,' , 'V,'2
E493 202A2A 950 .BY ' , '*,*,*,*, '$0D,$0D
E49A 203634 951 .BY ' , '6,'4,'K,' , 'R,'A,'M,' , 'S,'Y,'S,'T,'E,'M,' ,
E4AB 005C 952 .BY $00,$5C

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```

954 ;set output device (patch)
955 ;
E4AD 48 956 SE4AD PHA
E4AE 20C9FF 957 JSR SFFC9      ;perform actual open for output
E4B1 AA 958 TAX             ;save possible error code
E4B2 68 959 PLA             ;restore entry accumulator
E4B3 9001 960 BCC BE4B6     ;if an error encountered,
E4B5 8A 961 TXA             ;return with error number in A
E4B6 60 962 BE4B6 RTS
963 ;
964 ;unused area follows
965 ;
E4B7 AAAAAAA 966 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA
E4BF AAAAAAA 967 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA
E4C7 AAAAAAA 968 .BY $AA,$AA,$AA,$AA,SAA,$AA,$AA,$AA
E4CF AAAAAAA 969 .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
E4D7 AAAAAAA 970 .BY $AA,$AA,$AA
971 ;
972 ;clear a byte in color RAM
973 ;
E4DA AD21D0 974 SE4DA LDA XD021      ;use background # 0 color
E4DD 91F3 975 STA (ZF3),Y      ;to clear color RAM
E4DF 60 976 RTS
977 ;
978 ;pause after finding a file on cassette
979 ;
E4E0 6902 980 SE4EO ADC $02      ;set maximum pause to 256 - 512 jiffies
E4E2 A491 981 BE4E2 LDY Z91      ;check keyboard scan result
E4E4 C8 982 INY
E4E5 D004 983 BNE BE4EB      ;exit if a key depressed
E4E7 C5A1 984 CMP ZA1
E4E9 D0F7 985 BNE BE4E2      ;repeat until delay complete
E4EB 60 986 BE4EB RTS

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988 ;baud rate factor table for International machines
989 ;((clock frequency/baud rate/2)-100)
990 ;
E4EC 1926 991 TE4EC .WO $2619 ;50 baud
E4EE 4419 992 .WO $1944 ;75
E4FO 1A11 993 .WO $111A ;110
E4F2 E80D 994 .WO $0DE8 ;134.5
E4F4 700C 995 .WO $0C70 ;150
E4F6 0606 996 .WO $0606 ;300
E4F8 D102 997 .WO $02D1 ;600
E4FA 3701 998 .WO $0137 ;1200
E4FC AE00 999 .WO $00AE ;1800
E4FE 6900 1000 .WO $0069 ;2400
1001 ;
1002 ;read base address of I/O devices into XY
1003 ;
E500 A200 1004 JE500 LDX $00
E502 AODC 1005 LDY $DC ;point to CIA1 in XY
E504 60 1006 RTS
1007 ;
1008 ;read screen organization into XY
1009 ;
E505 A228 1010 JE505 LDX $28 ;# columns
E507 A019 1011 LDY $19 ;# rows
E509 60 1012 RTS
1013 ;
1014 ;read/set XY cursor position
1015 ;
E50A B007 1016 JE50A BCS BE513 ;if carry set, read cursor position
E50C 86D6 1017 STX ZD6 ;set cursor line # from X
E50E 84D3 1018 STY ZD3 ;set position of cursor on line from Y
E510 206CE5 1019 JSR SE56C ;set address of current screen line
E513 A6D6 1020 BE513 LDX ZD6 ;read cursor line number into X
E515 A4D3 1021 LDY ZD3 ;read position of cursor on line into Y
E517 60 1022 RTS

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```

1024 ;initialize screen and keyboard
1025 ;
E518 20A0E5 1026 SE518 JSR SE5AO      ;initialize video chip, set default I/O
E51B A900 1027 LDA $00
E51D 8D9102 1028 STA X0291      ;enable shift mode
E520 85CF 1029 STA ZCF       ;clear cursor blink phase
E522 A948 1030 LDA <WEB48
E524 8D8F02 1031 STA X028F      ;set address of keyboard decode routine
E527 A9EB 1032 LDA >WEB48
E529 8D9002 1033 STA X0290      ;& high byte
E52C A90A 1034 LDA $0A
E52E 8D8902 1035 STA X0289      ;set maximum length of keyboard buffer
E531 8D8C02 1036 STA X028C      ;set repeat key delay counter
E534 A90E 1037 LDA $0E
E536 8D8602 1038 STA X0286      ;set current color code
E539 A904 1039 LDA $04
E53B 8D8802 1040 STA X028B      ;set repeat key frequency counter
E53E A90C 1041 LDA $0C
E540 85CD 1042 STA ZCD       ;set cursor flash timer
E542 85CC 1043 STA ZCC       ;disable cursor flash
E544 AD8802 1044 SE544 LDA X0288 ;fetch screen memory start page
E547 0980 1045 ORA $80       ;set bit 7 to indicate 40 character line
E549 A8 1046 TAY
E54A A900 1047 LDA $00
E54C AA 1048 TAX
E54D 94D9 1049 BE54D STY ZD9,X ;build screen line address table
E54F 18 1050 CLC
E550 6928 1051 ADC $28
E552 9001 1052 BCC BE555
E554 C8 1053 INY
E555 E8 1054 BE555 INX
E556 E01A 1055 CPX $1A
E558 D0F3 1056 BNE BE54D ;repeat for 25 lines
E55A A9FF 1057 LDA $FF
E55C 95D9 1058 STA ZD9,X
E55E A218 1059 LDX $18      ;line count - 1
E560 20FFE9 1060 BE560 JSR SE9FF ;clear a line
E563 CA 1061 DEX
E564 10FA 1062 BPL BE560 ;loop till screen cleared
E566 A000 1063 JE566 LDY $00
E568 84D3 1064 STY ZD3      ;cursor at position 0
E56A 84D6 1065 STY ZD6      ;and line 0

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```

1067 ;set address of current screen line
1068 ;
E56C A6D6 1069 SE56C LDX ZD6      ;get cursor line number in X
E56E A5D3 1070 LDA ZD3          ;and position of cursor on line in A
E570 B4D9 1071 BE570 LDY ZD9,X    ;check screen line address table
E572 3008 1072 BMI BE57C
E574 18   1073 CLC              ;if on an 80 character line,
E575 6928 1074 ADC $28          ;add 40 to
E577 85D3 1075 STA ZD3          ;position of cursor on line
E579 CA   1076 DEX              ;point to preceding line
E57A 10F4 1077 BPL BE570        ;and repeat if screen top not reached
E57C B5D9 1078 BE57C LDA ZD9,X    ;fetch high byte of screen line address
E57E 2903 1079 AND $03          ;strip 40/80 character line flag
E580 0D8802 1080 ORA X0288      ;add screen memory page
E583 85D2 1081 STA ZD2          ;to set high of pointer to screen line
E585 BDFOEC 1082 LDA TECFO,X    ;use line number and table of low bytes
E588 85D1 1083 STA ZD1          ;to set low byte of ptr to screen line
E58A A927 1084 LDA $27          ;set initial max length of current line
E58C E8   1085 INX
E58D B4D9 1086 BE58D LDY ZD9,X    ;exit if on a 40 character line
E58F 3006 1087 BMI BE597
E591 18   1088 CLC
E592 6928 1089 ADC $28          ;else add 40
E594 E8   1090 INX
E595 10F6 1091 BPL BE58D        ;and repeat one time
E597 85D5 1092 BE597 STA ZD5      ;save maximum length current line
E599 60   1093 RTS
1094 ;
E59A 20AOE5 1095 JSR SE5AO      ;not referenced!!
E59D 4C66E5 1096 JMP JE566

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1098 ;set video chip to std values and I/O devices to default
1099 ;
E5A0 A903 1100 SE5A0 LDA $03
E5A2 859A 1101 STA Z9A      ;set output device (screen)
E5A4 A900 1102 LDA $00
E5A6 8599 1103 STA Z99      ;set input device (keyboard)
E5A8 A22F 1104 LDX $2F
E5AA BDB8EC 1105 BE5AA LDA TECB9-1,X ;use standard table values to
E5AD 9DFFCF 1106 STA XD000-1,X ;initialize video chip
E5B0 CA    1107 DEX
E5B1 D0F7 1108 BNE BE5AA   ;repeat to move all 47 values
E5B3 60    1109 RTS
1110 ;
1111 ;fetch a character from keyboard buffer
1112 ;
E5B4 AC7702 1113 SE5B4 LDY X0277 ;save bottom char of keyboard buffer
E5B7 A200 1114 LDX $00
E5B9 BD7802 1115 BE5B9 LDA X0277+1,X ;move keyboard queue down one
E5BC 9D7702 1116 STA X0277,X
E5BF E8    1117 INX
E5C0 E4C6 1118 CPX ZC6      ;check length of queue
E5C2 D0F5 1119 BNE BE5B9 ;loop until all moved
E5C4 C6C6 1120 DEC ZC6      ;subtract one from length of queue
E5C6 98    1121 TYA      ;return with character in A
E5C7 58    1122 CLI      ;allow IRQ's again
E5C8 18    1123 CLC      ;clear error flag
E5C9 60    1124 RTS

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1126 ;wait for a Return from keyboard
1127 ;
E5CA 2016E7 1128 BE5CA JSR SE716      ;echo character on screen
E5CD A5C6 1129 BE5CD LDA ZC6        ;move keyboard count
E5CF 85CC 1130 STA ZCC            ;to cursor enable flag (00=flash)
E5D1 8D9202 1131 STA X0292        ;and auto scroll down flag
E5D4 FOF7 1132 BEQ BE5CD        ;loop until something arrives from kbd
E5D6 78   1133 SEI
E5D7 A5CF 1134 LDA ZCF            ;if cursor blink phase 1
E5D9 F00C 1135 BEQ BE5E7
E5DB A5CE 1136 LDA ZCE            ;get character under cursor
E5DD AE8702 1137 LDX X0287        ;& color of character under cursor
E5E0 A000 1138 LDY $00
E5E2 84CF 1139 STY ZCF            ;clear cursor blink phase
E5E4 2013EA 1140 JSR SEA13        ;store character on screen
E5E7 2084E5 1141 BE5E7 JSR SESB4    ;fetch a character from the keyboard buffer
E5EA C983 1142 CMP $83           ;check for shift of Run/Stop key
E5EC D010 1143 BNE BE5FE
E5EE A209 1144 LDX $09            ;if so, set count for move
E5FO 78   1145 SEI
E5F1 86C6 1146 STX ZC6            ;force keyboard buffer count
E5F3 BDE6EC 1147 BE5F3 LDA TCE7-1,X ;move "Load/Run" into keyboard buffer
E5F6 9D7602 1148 STA X0277-1,X
E5F9 CA   1149 DEX
E5FA DOF7 1150 BNE BE5F3        ;repeat until all characters moved
E5FC FOCF 1151 BEQ BE5CD        ;go get first char from forced string
1152 ;
E5FE C90D 1153 BE5FE CMP $0D           ;if Return,
E600 DOC8 1154 BNE BE5CA
E602 A4D5 1155 LDY ZD5            ;move screen line length
E604 84D0 1156 STY ZD0           ;to save area
E606 B1D1 1157 BE606 LDA (ZD1),Y ;check for blanks at end of line
E608 C920 1158 CMP $20           ;and remove them
E60A D003 1159 BNE BE60F
E60C 88   1160 DEY
E60D DOF7 1161 BNE BE606
E60F C8   1162 BE60F INY
E610 84C8 1163 STY ZC8            ;set end of line pointer for input
E612 A000 1164 LDY $00
E614 8C9202 1165 STY X0292        ;enable auto scroll flag
E617 84D3 1166 STY ZD3            ;set position of cursor on line
E619 84D4 1167 STY ZD4            ;clear string flag
E61B A5C9 1168 LDA ZC9           ;get saved screen line number
E61D 301B 1169 BMI BE63A         ;if valid
E61F A6D6 1170 LDX ZD6
E621 20EDE6 1171 JSR SE6ED        ;and equal to original
E624 E4C9 1172 CPX ZC9
E626 D012 1173 BNE BE63A
E628 A5CA 1174 LDA ZCA
E62A 85D3 1175 STA ZD3            ;set char position to original value
E62C C5C8 1176 CMP ZC8           ;if char position is past end of line,
E62E 900A 1177 BCC BE63A         ;get character from screen
E630 B02B 1178 BCS BE65D         ;else exit with a return

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1180 ;get character from device 0 or 3 (keyboard or screen)
1181 ;
E632 98    1182 JE632 TYA
E633 48    1183     PHA
E634 8A    1184     TXA      ;save XY on stack
E635 48    1185     PHA
E636 A5D0    1186     LDA ZDO   ;test saved screen line length
E638 F093    1187     BEQ BE5CD ;if zero, wait for return
1188 ;
1189 ;get character from current screen line
1190 ;
E63A A4D3    1191 BE63A LDY ZD3   ;get position of cursor on current line
E63C B1D1    1192     LDA (ZD1),Y ;then current screen character
E63E 85D7    1193     STA ZD7   ;and save it
E640 293F    1194     AND $3F    ;save low order 6 bits
E642 06D7    1195     ASL ZD7   ;if bit 6 is set in original
E644 24D7    1196     BIT ZD7
E646 1002    1197     BPL BE64A
E648 0980    1198     ORA $80    ;set bit 7 in converted character
E64A 9004    1199 BE64A BCC BE650 ;if bit 7 is set in original
E64C A6D4    1200     LDX ZD4   ;and in a string
E64E D004    1201     BNE BE654 ;then don't change bit 6
E650 7002    1202 BE650 BVS BE654 ;if bit 5 is clear in original
E652 0940    1203     ORA $40    ;set bit 6 in converted character
E654 E6D3    1204 BE654 INC ZD3   ;increment position of cursor on line
E656 2084E6  1205 JSR SE684  ;check for a quote
E659 C4C8    1206 CPY ZC8   ;if end of line reached
E65B D017    1207 BNE BE674
E65D A900    1208 BE65D LDA $00
E65F 85D0    1209 STA ZDO   ;clear copy of screen line length
E661 A90D    1210 LDA $0D   ;force a Return
E663 A699    1211 LDX Z99
E665 E003    1212 CPX $03    ;if input device is 3 (screen)
E667 F006    1213 BEQ BE66F  ;echo character on screen
E669 A69A    1214 LDX Z9A
E66B E003    1215 CPX $03    ;if output device is screen
E66D F003    1216 BEQ BE672  ;replace character with a Return
E66F 2016E7  1217 BE66F JSR SE716 ;echo character on screen
E672 A90D    1218 BE672 LDA $0D   ;replace character with a Return
E674 85D7    1219 BE674 STA ZD7 ;and save as last character
E676 68     1220 PLA
E677 AA     1221 TAX
E678 68     1222 PLA
E679 A8     1223 TAY      ;restore XY
E67A A5D7    1224 LDA ZD7
E67C C9DE    1225 CMP $DE    ;if character is PI
E67E D002    1226 BNE BE682  ;return with code for PI
E680 A9FF    1227 LDA $FF
E682 18     1228 BE682 CLC
E683 60     1229 RTS

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1231 ;check for a quote mark and set flag
1232 ;
E684 C922 1233 SE684 CMP '" ;if character is a quote
E686 D008 1234 BNE BE690
E688 A5D4 1235 LDA ZD4
E68A 4901 1236 EOR $01 ;complement string flag
E68C 85D4 1237 STA ZD4
E68E A922 1238 LDA '" ;and restore quote code in A
E690 60 1239 EE690 RTS
1240 ;
1241 ;fill screen at current position
1242 ;
E691 0940 1243 JE691 ORA $40 ;map shifted characters
E693 A6C7 1244 JE693 LDX ZC7 ;if reverse switch is on
E695 F002 1245 BEQ BE699
E697 0980 1246 JE697 ORA $80 ;add reverse video bit
E699 A6D8 1247 BE699 LDX ZD8 ;if any pending inserts
E69B F002 1248 BEQ BE69F
E69D C618 1249 DEC ZD8 ;decrement pending inserts count
E69F AE8602 1250 BE69F LDX X0286 ;fetch current color code
E6A2 2013EA 1251 JSR SEA13 ;add character to screen
E6A5 20B6E6 1252 JSR SE6B6 ;get/insert new line
1253 ;
1254 ;return from output to the screen
1255 ;
E6A8 68 1256 BE6A8 PLA
E6A9 A8 1257 TAY
E6AA A5D8 1258 LDA ZD8 ;if any pending inserts,
E6AC F002 1259 BEQ BE6B0
E6AE 46L4 1260 LSR ZD4 ;reset string mode flag
E6B0 68 1261 BE6B0 PLA
E6E1 AA 1262 TAX ;restore XA
E6B2 68 1263 PLA
E6B3 18 1264 CLC
E6R4 58 1265 CLI ;allow IRQ's
E6E5 60 1266 RTS

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1268 ;get/insert new line
1269 ;
E6B6 20B3E8 1270 SE6B6 JSR SE8B3 ;check for end of a screen line
E6B9 E6D3 1271 INC ZD3 ;advance cursor position
E6BB A5D5 1272 LDA ZD5
E6BD C5D3 1273 CMP ZD3 ;if beyond maximum position,
E6BF B03F 1274 BCS BE700 ;exit
E6C1 C94F 1275 CMP $4F ;if not at 79
E6C3 F032 1276 BEQ BE6F7
E6C5 AD9202 1277 LDA X0292 ;and in auto scroll mode
E6C8 F003 1278 BEQ BE6CD ;continue
E6CA 4C67E9 1279 JMP JE967 ;else insert a blank line in screen RAM
1280 ;
E6CD A6D6 1281 BE6CD LDX ZD6 ;if in auto scroll mode
E6CF E019 1282 CPX $19 ;and cursor is on line 25
E6D1 9007 1283 BCC BE6DA
E6D3 20EAE8 1284 JSR SE8EA ;scroll screen
E6D6 C6D6 1285 DEC ZD6 ;subtract 1 from cursor line #
E6D8 A6D6 1286 LDX ZD6
E6DA 16D9 1287 BE6DA ASL ZD9,X ;set an 80 character line
E6DC 56D9 1288 LSR ZD9,X
E6DE E8 1289 INX
E6DF B5D9 1290 LDA ZD9,X ;set following line to 40 characters
E6E1 0980 1291 ORA $80
E6E3 95D9 1292 STA ZD9,X
E6E5 CA 1293 DEX
E6E6 A5D5 1294 LDA ZD5
E6E8 18 1295 CLC
E6E9 6928 1296 ADC $28 ;add 40 to line length of current line
E6EB 85D5 1297 STA ZD5
E6ED B5D9 1298 SE6ED LDA ZD9,X
E6EF 3003 1299 BMI BE6F4 ;if current line is not 80 char line
E6F1 CA 1300 DEX ;decrement line count
E6F2 D0F9 1301 BNE SE6ED ;and repeat
E6F4 4CFOE9 1302 BE6F4 JMP SE9FO ;reset screen line address and return
1303 ;
E6F7 C6D6 1304 BE6F7 DEC ZD6 ;decrement cursor line #
E6F9 207CE8 1305 JSR SE87C ;set next line number
E6FC A900 1306 LDA $00
E6FE 85D3 1307 STA ZD3 ;set cursor position on line to 0
E700 60 1308 BE700 RTS
1309 ;
1310 ;move backwards over a line boundary
1311 ;
E701 A6D6 1312 SE701 LDX ZD6 ;if at top of screen
E703 D006 1313 BNE BE70B
E705 86D3 1314 STX ZD3 ;set cursor position to line 0
E707 68 1315 PLA
E708 68 1316 PLA ;remove own return address
E709 D09D 1317 BNE BE6A8 ;and exit
E70B CA 1318 BE70B DEX ;else back up one line
E70C 86D6 1319 STX ZD6
E70E 206CE5 1320 JSR SE56C ;set address of current screen line
E711 A4D5 1321 LDY ZD5 ;move line length of current line
E713 84D3 1322 STY ZD3 ;to position of cursor on line
E715 60 1323 RTS

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        1325 ;put a character to screen (device 3)
        1326 ;
E716 48      1327 SE716 PHA      ;save character on stack
E717 85D7    1328 STA ZD7      ;and in temporary field
E719 8A      1329 TXA
E71A 48      1330 PHA
E71B 98      1331 TYA
E71C 48      1332 PHA      ;save XY
E71D A900    1333 LDA $00
E71F 85DO    1334 STA ZD0      ;set saved screen line length to 0
E721 A4D3    1335 LDY ZD3      ;get character position
E723 A5D7    1336 LDA ZD7      ;and character
E725 1003    1337 BPL BE72A
E727 4CD4E7  1338 JMP JE7D4      ;if shifted character, skip following
        1339 ;
E72A C90D    1340 BE72A CMP $0D      ;if Return
E72C D003    1341 BNE BE731
E72E 4C91E8  1342 JMP JE891      ;perform Return function
        1343 ;
E731 C920    1344 BE731 CMP $20      ;if printable character
E733 9010    1345 BCC BE745
E735 C960    1346 CMP $60
E737 9004    1347 BCC BE73D
E739 29DF    1348 AND $DF
E73B D002    1349 BNE BE73F      ;and not a space
E73D 293F    1350 BE73D AND $3F      ;map to screen code
E73F 2084E6  1351 BE73F JSR SE684      ;check for a quote
E742 4C93E6  1352 JMP JE693      ;and fill screen
        1353 ;
E745 A6D8    1354 BE745 LDX ZD8      ;if non-printable
E747 F003    1355 BEQ BE74C      ;and inserts pending
E749 4C97E6  1356 JMP JE697      ;do not use code
        1357
E74C C914    1358 BE74C CMP $14      ;if Delete code
E74E D02E    1359 BNE BE77E
E750 98      1360 TYA
E751 D006    1361 BNE BE759      ;and not beyond left margin
E753 2001E7  1362 JSR SE701      ;go backwards over line boundary
E756 4C73E7  1363 JMP JE773      ;insert a blank
        1364 ;
E759 20A1E8  1365 BE759 JSR SE8A1      ;check for cursor at line beginning
E75C 88      1366 DEY
E75D 84D3    1367 STY ZD3      ;adjust cursor position on line
E75F 2024EA  1368 JSR SEA24      ;set color memory address
E762 C8      1369 BE762 INY
E763 B1D1    1370 LDA (ZD1),Y      ;compress screen line
E765 88      1371 DEY
E766 91D1    1372 STA (ZD1),Y
E768 C8      1373 INY
E769 B1F3    1374 LDA (ZF3),Y      ;and color memory
E76B 88      1375 DEY
E76C 91F3    1376 STA (ZF3),Y
E76E C8      1377 INY
E76F C4D5    1378 CPY ZD5      ;up to end of line
E771 DOEF    1379 BNE BE762
E773 A920    1380 JE773 LDA $20      ;and insert blank
E775 91D1    1381 STA (ZD1),Y      ;at end
E777 AD8602  1382 LDA X0286      ;insert current color code
E77A 91F3    1383 STA (ZF3),Y      ;in color memory
E77C 104D    1384 BPL BE7CB

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E77E A6D4    1385 BE77E LDX ZD4      ;if in string mode
E780 F003    1386     BEQ BE785      ;don't use control functions
E782 4C97E6   1387     JMP JE697
                                1388 ;
E785 C912    1389 BE785 CMP $12      ;if Reverse key
E787 D002    1390     BNE BE78B
E789 85C7    1391     STA ZC7      ;set reverse video switch
E78B C913    1392 BE78B CMP $13      ;if Home key
E78D D003    1393     BNE BE792
E78F 2066E5   1394     JSR JE566      ;re-initialize cursor position
E792 C91D    1395 BE792 CMP $1D      ;if Cursor Right
E794 D017    1396     BNE BE7AD
E796 C8      1397     INY
E797 20B3E8   1398     JSR SE8B3      ;increment character position
E79A 84D3    1399     STY ZD3
E79C 88      1400     DEY
E79D C4D5    1401     CPY ZD5      ;if at line end
E79F 9009   1402     BCC BE7AA
E7A1 C6D6    1403     DEC ZD6      ;decrement cursor line number
E7A3 207CE8   1404     JSR SE87C      ;go to next line
E7A6 A000    1405     LDY $00
E7A8 84D3    1406 BE7A8 STY ZD3      ;set position of cursor on line
E7AA 4CA8E6   1407 BE7AA JMP BE6A8      ;and exit
                                1408 ;
E7AD C911    1409 BE7AD CMP $11      ;if Cursor Down
E7AF D01D    1410     BNE BE7CE
E7B1 18      1411     CLC
E7B2 98      1412     TYA
E7B3 6928    1413     ADC $28      ;advance 40 positions
E7B5 A8      1414     TAY
E7B6 E6D6    1415     INC ZD6      ;increment cursor line number
E7B8 C5D5    1416     CMP ZD5      ;if not beyond line end
E7BA 90EC    1417     BCC BE7A8
E7BC FOEA    1418     BEQ BE7A8
E7BE C6D6    1419     DEC ZD6      ;exit
E7C0 E928    1420 BE7C0 SBC $28      ;else back up one line
E7C2 9004    1421     BCC BE7C8      ;decrease character position by 40
E7C4 85D3    1422     STA ZD3      ;exit if underflow
E7C6 D0F8    1423     BNE BE7C0      ;else reset position of cursor on line
E7CB 207CE8   1424 BE7C8 JSR SE87C      ;set next line number
E7CB 4CA8E6   1425 BE7CB JMP BE6A8      ;exit
                                1426 ;
E7CE 20CB8    1427 BE7CE JSR SE8CB      ;check for a color code
E7D1 4C44EC   1428     JMP JEC44      ;check for special CHR$ codes, return

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1430 ;put shifted characters to screen
1431 ;
E7D4 297F 1432 JE7D4 AND $7F      ;remove shift bit
E7D6 C97F 1433 CMP $7F          ;if code for PI
E7D8 D002 1434 BNE BE7DC
E7DA A95E 1435 LDA $5E          ;set screen code for PI
E7DC C920 1436 BE7DC CMP $20      ;if printable
E7DE 9003 1437 BCC BE7E3
E7E0 4C91E6 1438 JMP JE691      ;go fill screen
1439 ;
E7E3 C90D 1440 BE7E3 CMP $0D      ;if shifted Return
E7E5 D003 1441 BNE BE7EA
E7E7 4C91E8 1442 JMP JE891      ;do Return function
1443 ;
E7EA A6D4 1444 BE7EA LDX ZD4      ;if in string mode
E7EC D03F 1445 BNE BE82D      ;do not perform control functions
E7EE C914 1446 CMP $14          ;if Insert key
E7FO D037 1447 BNE BE829
E7F2 A4D5 1448 LDY ZD5
E7F4 B1D1 1449 LDA (ZD1),Y
E7F6 C920 1450 CMP $20          ;and last character of line is a blank
E7F8 D004 1451 BNE BE7FE
E7FA C4D3 1452 CPY ZD3          ;and not also current char position
E7FC D007 1453 BNE BE805      ;then enough space on this line
E7FE C04F 1454 BE7FE CPY $4F      ;if last character of line not blank
E800 F024 1455 BEQ BE826      ;and 80 character line, ignore
E802 2065E9 1456 JSR SE965      ;else insert a blank line in screen RAM
E805 A4D5 1457 BE805 LDY ZD5      ;get new maximum character position
E807 2024EA 1458 JSR SEA24      ;set color memory address
E80A 88 1459 BE80A DEY      ;from new maximum character position
E80B B1D1 1460 LDA (ZD1),Y      ;move characters
E80D C8 1461 INY
E80E 91D1 1462 STA (ZD1),Y      ;towards end of line
E810 88 1463 DEY
E811 B1F3 1464 LDA (ZF3),Y      ;plus color memory
E813 C8 1465 INY
E814 91F3 1466 STA (ZF3),Y
E816 88 1467 DEY
E817 C4D3 1468 CPY ZD3          ;up to current position
E819 DOEF 1469 BNE BE80A
E81B A920 1470 LDA $20
E81D 91D1 1471 STA (ZD1),Y      ;insert a blank
E81F AD8602 1472 LDA X0286
E822 91F3 1473 STA (ZF3),Y      ;insert current color in color memory
E824 E6D8 1474 INC ZD8          ;add 1 to pending inserts count
L826 4CA8E6 1475 BE826 JMP BE6A8      ;and exit
1476 ;
E829 A6D8 1477 BE829 LDX ZD8      ;if any pending inserts
E82B F005 1478 BEQ BE832
E82D 0940 1479 BE82D ORA $40      ;add screen shift bit
E82F 4C97E6 1480 JMP JE697      ;go fill screen
1481 ;
E832 C911 1482 BE832 CMP $11      ;if Cursor Up key
E834 D016 1483 BNE BE84C
E836 A6D6 1484 LDX ZD6
E838 F037 1485 BEQ BE871      ;and cursor not on top screen line
E83A C6D6 1486 DEC ZD6
E83C A5D3 1487 LDA ZD3
E83E 38 1488 SEC
E83F E928 1489 SBC $28

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E841 9004    1490      BCC BE847 ;and current cursor position >= 40
E843 85D3    1491      STA ZD3 ;decrease count by 40
E845 102A    1492      BPL BE871 ;and exit
E847 206CE5   1493 BE847 JSR SE56C ;set address of current screen line
E84A D025    1494      BNE BE871
E84C C912    1495 BE84C CMP $12 ;if Reverse Off key
E84E D004    1496      BNE BE854
E850 A900    1497      LDA $00
E852 85C7    1498      STA ZC7 ;clear reverse video switch
E854 C91D    1499 BE854 CMP $1D ;if Cursor Left
E856 D012    1500      BNE BE86A
E858 98     1501      TYA
E859 F009    1502      BEQ BE864 ;and cursor not beyond left margin,
E85B 20ALE8   1503 JSR SE8A1 ;check for left edge of a screen line
E85E 88     1504      DEY ;back up cursor one position
E85F 84D3    1505 STY ZD3 ;and set cursor to new position
E861 4CA8E6   1506 JMP BE6A8 ;and exit
E864 2001E7   1507 ; ;go backwards over line boundary
E867 4CA8E6   1508 BE864 JSR SE701 ;and exit
E868 4CA8E6   1509 JMP BE6A8
E86A C913    1510 ; ;if CLR key
E86C D006    1511 BE86A CMP $13
E86E 2044E5   1512 BNE BE874
E86F 84D3    1513 JSR SE544 ;re-initialize screen
E871 4CA8E6   1514 BE871 JMP BE6A8 ;and exit
E874 0980    1515 ; ;set next line number
E876 20CBE8   1516 BE874 ORA $80 ;restore code to original value
E877 4C4FEC   1517 JSR SE8CB ;check for a color change keystroke
E879 4C4FEC   1518 JMP JEC4F ;check for special CHR$ values and return
E87A 46C9    1519 ; ;set saved line # on screen invalid
E87B A6D6    1520 ; ;get current line number
E880 E8     1521 ; ;and increment it
E881 E019    1522 SE87C LSR ZC9 ;if at end of screen
E883 D003    1523 LDX ZD6 ;set saved line # on screen invalid
E885 20EAE8   1524 BE880 INX ;get current line number
E886 E019    1525 CPX $19 ;and increment it
E888 B5D9    1526 BNE BE888 ;if at end of screen
E889 B5D9    1527 JSR SE8EA ;scroll screen
E88A 10F4    1528 BE888 LDA ZD9,X ;if 80 character line,
E88B 86D6    1529 BPL BE880 ;repeat
E88C 86D6    1530 STX ZD6 ;store new line number
E88E 4C6CE5   1531 JMP SE56C ;set addr of current screen line and return

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        1533 ;action for Return
1534 ;
E891 A200 1535 JE891 LDX $00
E893 86D8 1536 STX ZD8      ;clear pending inserts count
E895 86C7 1537 STX ZC7      ;reset reverse video switch
E897 86D4 1538 STX ZD4      ;reset string flag
E899 86D3 1539 STX ZD3      ;set cursor to position 0 on line
E89B 207CE8 1540 JSR SE87C  ;set next line number
E89E 4CA8E6 1541 JMP BE6A8  ;and exit
1542 ;
1543 ;move cursor to previous line if at start of a screen line
1544 ;
E8A1 A202 1545 SE8A1 LDX $02
E8A3 A900 1546 LDA $00
E8A5 C5D3 1547 BE8A5 CMP ZD3  ;if cursor is not
E8A7 F007 1548 8EQ BE8B0  ;at the left edge of a screen line,
E8A9 18   1549 CLC
E8AA 6928 1550 ADC $28  ;set A for next left edge
E8AC CA   1551 DEX
E8AD DOF6 1552 BNE BE8A5  ;and repeat a maximum of 2 times
E8AF 60   1553 RTS
1554 ;
E8B0 C6D6 1555 BE8B0 DEC ZD6  ;since cursor at left edge,
E8B2 60   1556 RTS      ;move cursor to previous line
1557 ;
1558 ;move cursor to next line if at end of a screen line
1559 ;
E8B3 A202 1560 SE8B3 LDX $02
E8B5 A927 1561 LDA $27
E8B7 C5D3 1562 BE8B7 CMP ZD3  ;if cursor is not at the end of a line
E8B9 F007 1563 BEQ BE8C2
E8BB 18   1564 CLC
E8BC 6928 1565 ADC $28  ;point to next end of screen line
E8BE CA   1566 DEX
E8BF DOF6 1567 BNE BE8B7  ;and repeat a maximum of 2 times
E8C1 60   1568 RTS
1569 ;
E8C2 A6D6 1570 BE8C2 LDX ZD6  ;since cursor at right edge,
E8C4 E019 1571 CPX $19
E8C6 F002 1572 BEQ BE8CA
E8C8 E6D6 1573 INC ZD6      ;add 1 to cursor line number
E8CA 60   1574 BE8CA RTS    ;if cursor not on last screen line
1575 ;
1576 ;check for a color change keystroke
1577 ;
E8CB A20F 1578 SE8CB LDX $0F
E8CD DDDAE8 1579 BE8CD CMP TE8DA,X  ;compare keystroke to color codes
E8D0 F004 1580 8EQ BE8D6
E8D2 CA   1581 DEX
E8D3 10F8 1582 BPL BE8CD  ;repeat for all 16 codes
E8D5 60   1583 RTS
1584 ;
E8D6 8E8602 1585 BE8D6 STX X0286  ;set current color code upon a match
E8D9 60   1586 RTS
1587 ;
E8DA      1588 TE8DA = *          ;color codes
E8DA 90051C 1589 .8Y $90,$05,$10,$9F,$9C,$1E,$1F,$9E
E8E2 819596 1590 .8Y $81,$95,$96,$97,$98,$99,$9A,$98

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1592 ;scroll screen
1593 ;
E8EA A5AC 1594 SE8EA LDA ZAC      ;save I/O pointers on stack
E8EC 48   1595 PHA
E8ED A5AD 1596 LDA ZAD
E8EF 48   1597 PHA
E8FO A5AE 1598 LDA ZAE
E8F2 48   1599 PHA
E8F3 A5AF 1600 LDA ZAF
E8F5 48   1601 PHA
E8F6 A2FF 1602 BE8F6 LDX $FF      ;initialize line pointer
E8F8 C6D6 1603 DEC ZD6          ;move cursor to previous line
E8FA C6C9 1604 DEC ZC9          ;also input cursor
E8FC CEA502 1605 DEC X02A5      ;and position of first 40 char line
E8FF E8   1606 BE8FF INX
E900 20FOE9 1607 JSR SE9FO      ;set screen address
E903 E018 1608 CPX $18
E905 B00C 1609 BCS BE913      ;if 24 lines not moved up,
E907 BDF1EC 1610 LDA TECFO+1,X  ;use screen line address table
E90A 85AC 1611 STA ZAC          ;to set next source address
E90C B5DA 1612 LDA ZDA,X      ;high byte also
E90E 20C8E9 1613 JSR SE9C8      ;move one line up
E911 30EC 1614 BMI BE8FF      ;and repeat
E913 20FFE9 1615 BE913 JSR SE9FF  ;clear last screen line
E916 A200 1616 LDX $00
E918 B5D9 1617 BE918 LDA ZD9,X
E91A 297F 1618 AND $7F
E91C B4DA 1619 LDY ZDA,X
E91E 1002 1620 BPL BE922
E920 0980 1621 ORA $80
E922 95D9 1622 BE922 STA ZD9,X
E924 E8   1623 INX
E925 E018 1624 CPX $18
E927 D0EF 1625 BNE BE918      ;repeat until bottom of screen reached
E929 A5F1 1626 LDA ZF1          ;set bottom line to 40 character
E92B 0980 1627 ORA $80
E92D 85F1 1628 STA ZF1
E92F A5D9 1629 LDA ZD9
E931 10C3 1630 BPL BE8F6
E933 E6D6 1631 INC ZD6
E935 EEA502 1632 INC X02A5      ;and position of first 40 char line
E938 A97F 1633 LDA $7F
E93A 8D00DC 1634 STA XDC00
E93D AD01DC 1635 LDA XDC01
E940 C9FB 1636 CMP $FB      ;if CTRL key is depressed,
E942 08   1637 PHP
E943 A97F 1638 LDA $7F
E945 8D00DC 1639 STA XDC00
E948 28   1640 PLP
E949 D00B 1641 BNE BE956
E94B A000 1642 LDY $00
E94D EA   1643 BE94D NOP      ;delay to slow scrolling down
E94E CA   1644 DEX
E94F DOFC 1645 BNE BE94D
E951 88   1646 DEY
E952 DOF9 1647 BNE BE94D
E954 84C6 1648 STY ZC6      ;clear keyboard buffer count
E956 A6D6 1649 BE956 LDX ZD6  ;put cursor line number in X
E958 68   1650 JE958 PLA
E959 85AF 1651 STA ZAF      ;restore I/O area from stack

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E95B 68      1652      PLA
E95C 85AE    1653      STA ZAE
E95E 68      1654      PLA
E95F 85AD    1655      STA ZAD
E961 68      1656      PLA
E962 85AC    1657      STA ZAC
E964 60      1658      RTS
1659 ;
1660 ;insert a blank line in screen RAM
1661 ;
E965 A6D6    1662 SE965 LDX ZD6      ;start from current cursor line position
E967 E8      1663 JE967 INX
E968 B5D9    1664 LDA ZD9,X
E96A 10FB    1665 BPL JE967 ;skip 80 column lines
E96C 8EA502  1666 STX X02A5 ;save position of first 40 column line
E96F EO18    1667 CPX $18 ;if line 24
E971 F0OE    1668 BEQ BE981
E973 900C    1669 BCC BE981
E975 20EAE8  1670 JSR SE8EA ;scroll screen
E978 AEA502  1671 LDX X02A5 ;first 40 column line beyond cursor
E97B CA      1672 DEX ;minus 1 = new cursor line number
E97C C6D6    1673 DEC ZD6 ;decrement cursor line number
E97E 4CDAE6  1674 JMP BE6DA ;and go reset screen line pointers
1675 ;
E981 A5AC    1676 BE981 LDA ZAC ;save I/O pointers on the stack
E983 48      1677 PHA
E984 A5AD    1678 LDA ZAD
E986 48      1679 PHA
E987 A5AE    1680 LDA ZAE
E989 48      1681 PHA
E98A A5AF    1682 LDA ZAF
E98C 48      1683 PHA
E98D A219    1684 LDX $19 ;initialize to line 25
E98F CA      1685 BE98F DEX
E990 20FOE9  1686 JSR SE9F0 ;set true screen address in ZD1/2
E993 ECA502  1687 CPX X02A5 ;if not past first 40 column line,
E996 900E    1688 BCC BE9A6
E998 F0OC    1689 BEQ BE9A6
E99A BDEFEC  1690 LDA TECFO-1,X ;use screen line address
E99D 85AC    1691 STA ZAC ;to set source address
E99F B5D8    1692 LDA ZD8,X
E9A1 20C8E9  1693 JSR SE9C8 ;move one line up
E9A4 30E9    1694 BMI BE98F ;and repeat
E9A6 20FFE9  1695 BE9A6 JSR SE9FF ;clear screen line
E9A9 A217    1696 LDX $17
E9AB ECA502  1697 BE9AB CPX X02A5 ;if first 40 column line = 24 or 25,
E9AE 900F    1698 BCC BE9BF
E9B0 B5DA    1699 LDA ZDA,X
E9B2 297F    1700 AND $7F ;set next line to 40 column
E9B4 B4D9    1701 LDY ZD9,X
E9B6 1002    1702 BPL BE9BA ;if current line is 80 column,
E9B8 0980    1703 ORA $80 ;make into 40 column
E9BA 95DA    1704 BE9BA STA ZDA,X
E9BC CA      1705 DEX
E9BD DOEC    1706 BNE BE9AB ;and repeat
E9BF AEA502  1707 BE9BF LDX X02A5 ;get first 40 column line beyond cursor
E9C2 20DAE6  1708 JSR BE6DA ;adjust line pointers
E9C5 4C58E9  1709 JMP JE958 ;and exit

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1711 ;move one screen line
1712 ;
E9C8 2903 1713 SE9C8 AND $03      ;adjust addr to clear 40/80 column flag
E9CA 0D8802 1714 ORA X0288      ;add screen memory page
E9CD 85AD 1715 STA ZAD        ;and save high part of address
E9CF 20E0E9 1716 JSR SE9EO      ;set color memory address in ZAE/F
E9D2 A027 1717 LDY $27
E9D4 B1AC 1718 BE9D4 LDA (ZAC),Y ;move screen byte
E9D6 91D1 1719 STA (ZDL),Y
E9D8 B1AE 1720 LDA (ZAE),Y ;move color memory byte
E9DA 91F3 1721 STA (ZF3),Y
E9DC 88 1722 DEY
E9DD 10F5 1723 BPL BE9D4      ;repeat for one screen line
E9DF 60 1724 RTS
1725 ;
1726 ;set color and screen addresses
1727 ;
E9E0 2024EA 1728 SE9EO JSR SEA24      ;set color memory pointer in ZF3/4
E9E3 A5AC 1729 LDA ZAC      ;move low byte of screen address
E9E5 85AE 1730 STA ZAE
E9E7 A5AD 1731 LDA ZAD      ;get high byte of screen address
E9E9 2903 1732 AND $03      ;strip 40/80 column flag
E9EB 09D8 1733 ORA $D8      ;add screen page for color memory
E9ED 85AF 1734 STA ZAF      ;and store result
E9EF 60 1735 RTS
1736 ;
1737 ;fetch screen address, depending on X
1738 ;
E9F0 BDFOEC 1739 SE9FO LDA TECFO,X ;set low byte of screen address
E9F3 85D1 1740 STA ZD1
E9F5 B5D9 1741 LDA ZD9,X      ;fetch high byte
E9F7 2903 1742 AND $03      ;strip 40/80 column flag
E9F9 0D8802 1743 ORA X0288      ;add screen memory page
E9FC 85D2 1744 STA ZD2      ;and store result
E9FE 60 1745 RTS

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1747 ;clear one screen line
1748 ;
E9FF A027 1749 SE9FF LDY $27
EA01 20FOE9 1750      JSR SE9FO    ;set true screen RAM address
EA04 2024EA 1751      JSR SEA24   ;set color memory address
EA07 A920 1752 BEA07 LDA $20
EA09 91D1 1753      STA (ZD1),Y ;clear a byte in video RAM
EA0B 20DAE4 1754      JSR SE4DA   ;clear a byte in color memory
EA0E EA 1755      NOP        ;(length adjustment for patch)
EA0F 88 1756      DEY
EA10 10F5 1757      BPL BEA07   ;repeat for one line
EA12 60 1758      RTS
1759 ;
1760 ;set cursor flash timing and color memory address
1761 ;
EA13 A8 1762 SEA13 TAY
EA14 A902 1763      LDA $02
EA16 85CD 1764      STA ZCD    ;init cursor flash timing countdown
EA18 2024EA 1765      JSR SEA24   ;set color memory address
EA1B 98 1766      TYA
1767 ;
1768 ;store a character to the screen
1769 ;
EA1C A4D3 1770 SEA1C LDY ZD3    ;fetch position on line
EA1E 91D1 1771      STA (ZD1),Y ;move char to current screen address
EA20 8A 1772      TXA        ;fetch character color
EA21 91F3 1773      STA (ZF3),Y ;move to color memory
EA23 60 1774      RTS
1775 ;
1776 ;set color memory address parallel to screen
1777 ;
EA24 A5D1 1778 SEA24 LDA ZD1    ;move low screen address
EA26 85F3 1779      STA ZF3    ;to low of color memory address
EA28 A5D2 1780      LDA ZD2    ;fetch high of screen address
EA2A 2903 1781      AND $03    ;clear 40/80 column flag
EA2C 09D8 1782      ORA $D8    ;adjust to color memory area
EA2E 85F4 1783      STA ZF4    ;set high of color memory address
EA30 60 1784      RTS

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1786 ;standard IRQ entry
1787 ;
EA31 20E AFF 1788 WEA31 JSR SFFEA ;bump real time clock
EA34 A5C C 1789 LDA ZCC ;check cursor flash enable flag
EA36 D029 1790 BNE BEA61 ;don't flash if non-zero
EA38 C6CD 1791 DEC ZCD ;decrement cursor flash countdown
EA3A D025 1792 BNE BEA61 ;and skip if not finished (flash delay)
EA3C A914 1793 LDA $14 ;reset jiffy count for next cursor flip
EA3E 85CD 1794 STA ZCD
EA40 A4D3 1795 LDY ZD3 ;fetch cursor position
EA42 46CF 1796 LSR ZCF ;shift cursor flash phase
EA44 AE8702 1797 LDX X0287 ;fetch color under cursor
EA47 B1D1 1798 LDA (ZD1),Y ;get character under cursor
EA49 B011 1799 BCS BEA5C ;branch if not first entry for character
EA4B E6CF 1800 INC ZCF ;set cursor flash phase to 1
EA4D 85CE 1801 STA ZCE ;save character under cursor
EA4F 2024EA 1802 JSR SEA24 ;set color memory address
EA52 B1F3 1803 LDA (ZF3),Y
EA54 8D8702 1804 STA X0287 ;save color under cursor
EA57 AE8602 1805 LDX X0286 ;get current color code
EA5A A5CE 1806 LDA ZCE ;get current character
EA5C 4980 1807 BEA5C EOR $80 ;invert character
EA5E 201CEA 1808 JSR SEALC ;display on screen
EA61 A501 1809 BEA61 LDA Z01 ;check cassette sense line
EA63 2910 1810 AND $10
EA65 F00A 1811 BEQ BEA71 ;if no buttons pressed
EA67 A000 1812 LDY $00
EA69 84C0 1813 STY ZCO ;clear tape motor flag
EA6B A501 1814 LDA Z01
EA6D 0920 1815 ORA $20 ;turn motor off
EA6F D008 1816 BNE BEA79 ;JMP
EA71 A5C0 1817 BEA71 LDA ZCO ;check tape motor flag
EA73 D006 1818 BNE BEA7B
EA75 A501 1819 LDA Z01 ;if flag shows motor should be on,
EA77 291F 1820 AND $1F ;turn cassette motor on
EA79 8501 1821 BEA79 STA Z01
EA7B 2087EA 1822 BEA7B JSR SEA87 ;scan keyboard
EA7E AD0DDC 1823 LDA XDCOD ;clear any pending IRQ's in ICR1
EA81 68 1824 PLA ;restore all registers
EA82 A8 1825 TAY
EA83 68 1826 PLA
EA84 AA 1827 TAX
EA85 68 1828 PLA
EA86 40 1829 RTI ;return from IRQ

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        1831 ;scan keyboard
        1832 ;
EA87 A900 1833 SEA87 LDA $00      ;clear shift/control flag
EA89 8D8D02 1834 STA X028D
EA8C A040 1835 LDY $40      ;set key pressed flag to default
EA8E 84CB 1836 STY ZCB      ;clear row
EA90 8D00DC 1837 STA XDC00
EA93 AE01DC 1838 LDX XDC01      ;check column
EA96 EOF0 1839 CPX $FF
EA98 F061 1840 BEQ BEAFB      ;if a key pressed
EA9A A8 1841 TAY      ;save in Y
EA9B A981 1842 LDA <TEB81      ;set address of standard keyboard table
EA9D 85F5 1843 STA ZF5      ;in keyboard table pointer
EA9F A9EB 1844 LDA >TEB81
EAA1 85F6 1845 STA ZF6      ;& high byte
EAA3 A9FE 1846 LDA $FE
EAA5 8D00DC 1847 STA XDC00      ;set first row
EA88 A208 1848 BEAA8 LDX $08      ;column count
EAAA 48 1849 PHA      ;save current row on stack
EAAB AD01DC 1850 BEAAB LDA XDC01      ;read a column
EAAE CD01DC 1851 CMP XDC01
EAB1 D0F8 1852 BNE BEAAB      ;wait until steady
EAB3 4A 1853 BEAB3 LSR A
EAB4 B016 1854 BCS BEACC      ;if a key is pressed,
EAB6 48 1855 PHA      ;save on stack
EAB7 B1F5 1856 LDA (ZF5),Y      ;fetch keyboard table contents
EAB9 C905 1857 CMP $05
EABB B00C 1858 BCS BEAC9      ;if < 5
EABD C903 1859 CMP $03      ;check for Commodore key
EABF F008 1860 BEQ BEAC9
EA01 0D8D02 1861 ORA X028D      ;add possible shift/control flag
EA04 8D8D02 1862 STA X028D      ;to set keyboard shift/control flag
EA07 1002 1863 BPL BEACB
EA09 84CB 1864 BEAC9 STY ZCB      ;set key pressed
EA0B 68 1865 BEACB PLA      ;restore last code read
EA0C C8 1866 BEACC INY
EA0D C041 1867 CPY $41
EA0F B00B 1868 BCS BEADC      ;if scan not complete,
EA11 CA 1869 DEX
EA12 D0DF 1870 BNE BEAB3      ;check next bit in column data
EA14 38 1871 SEC
EA15 68 1872 PLA      ;else restore row position
EA16 2A 1873 ROL A      ;select next row
EA17 8D00DC 1874 STA XDC00
EA1A DOCC 1875 BNE BEAA8      ;and repeat
EA1C 68 1876 BEADC PLA      ;restore code
EA1D 6C8F02 1877 JMP (X028F)      ;perform kbd decode routine (EB48)
EA1E 1878 ;
EA1F A4CB 1879 JEAE0 LDY ZCB      ;fetch key pressed
EA20 B1F5 1880 LDA (ZF5),Y      ;decode via keyboard table
EA22 AA 1881 TAX
EA25 C4C5 1882 CPY ZC5      ;if not the same as the last key,
EA27 F007 1883 BEQ BEAFO
EA29 A010 1884 LDY $10
EA30 8C8C02 1885 STY X028C      ;set repeat key delay counter
EA31 D036 1886 BNE BEB26      ;and skip repeat logic
EA32 1887 ;
EA33 297F 1888 BEAFO AND $7F      ;if repeat flag has
EA34 2C8A02 1889 BIT X028A      ;bit 7 set, repeat all keys
EA35 3016 1890 BMI BEB0D

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EAF7	7049	1891	BVS BEB42	;exit when flag > 63
EAF9	C97F	1892	CMP \$7F	
EAFB	F029	1893	BEAFB BEQ BEB26	
EAFD	C914	1894	CMP \$14	;delete
EAFF	F00C	1895	BEQ BEB0D	
EB01	C920	1896	CMP \$20	;space
EB03	F008	1897	BEQ BEB0D	
EB05	C91D	1898	CMP \$1D	;cursor right/left
EB07	F004	1899	BEQ BEB0D	
EB09	C911	1900	CMP \$11	;cursor down/up
EB0B	D035	1901	BNE BEB42	;if none of above, don't repeat
EB0D	AC8C02	1902	BEB0D LDY X028C	;check repeat key delay counter
EB10	F005	1903	BEQ BEB17	;countdown complete
EB12	CE8C02	1904	DEC X028C	;subtract 1 from repeat key delay ctr
EB15	D02B	1905	BNE BEB42	
EB17	CE8B02	1906	BEB17 DEC X028B	;subtract 1 from repeat key freq ctr
EB1A	D026	1907	BNE BEB42	
EB1C	A004	1908	LDY \$04	
EB1E	8C8B02	1909	STY X028B	;reset repeat key frequency counter
EB21	A4C6	1910	LDY ZC6	;check keyboard buffer count
EB23	88	1911	DEY	
EB24	101C	1912	BPL BEB42	;branch if something in keyboard queue
EB26	A4CB	1913	BEB26 LDY ZCB	;move current key
EB28	84C5	1914	STY ZC5	;to last key
EB2A	AC8D02	1915	LDY X028D	;move shift/control flag
EB2D	8C8E02	1916	STY X028E	;to last shift pattern
EB30	E0FF	1917	CPX \$FF	
EB32	F00E	1918	BEQ BEB42	
EB34	8A	1919	TXA	
EB35	A6C6	1920	LDX ZC6	;check keyboard queue length
EB37	EC8902	1921	CPX X0289	;against maximum allowed
EB3A	B006	1922	BCS BEB42	;branch if buffer full
EB3C	9D7702	1923	STA X0277,X	;else move character to keyboard queue
EB3F	E8	1924	INX	
EB40	86C6	1925	STX ZC6	
EB42	A97F	1926	BEB42 LDA \$7F	;add 1 to length of keyboard queue
EB44	8D00DC	1927	STA XDC00	;set PAL bits high
EB47	60	1928	RTS	
		1929 ;		
EB48	AD8D02	1930	WEB48 LDA X028D	
EB4B	C903	1931	CMP \$03	;check shift/control flag
EB4D	D015	1932	BNE BEB64	;for Commodore key and shift depressed
EB4F	CD8E02	1933	CMP X028E	;if so, and code is different
EB52	F0EE	1934	BEQ BEB42	;from last keyboard shift pattern
EB54	AD9102	1935	LDA X0291	
EB57	301D	1936	BMI BEB76	;and not in shift lock mode
EB59	AD18D0	1937	LDA XD018	
EB5C	4902	1938	EOR \$02	
EB5E	8D18D0	1939	STA XD018	;then toggle lower case/upper case bit
EB61	4C76EB	1940	JMP BEB76	;set video chip bit for proper display
				;exit

```

1942 ;select new keyboard table
1943 ;
EB64 0A 1944 BEE64 ASL A      ;double entry index
EB65 C908 1945 CMP $08       ;if index is too high,
EB67 9002 1946 BCC BEE6B
EB69 A906 1947 LDA $06       ;select "Control Key" keyboard
EB6B AA 1948 BEE6B TAX
EB6C BD79EB 1949 LDA TEB79,X ;fetch low byte from table
EB6F 85F5 1950 STA ZF5      ;and set keyboard table pointer
EB71 BD7AEB 1951 LDA TEB79+1,X
EB74 85F6 1952 STA ZF6      ;& high byte
EB76 4CEOEA 1953 BEE76 JMP JEAE0 ;exit
1954 ;
1955 ;table of keyboard table addresses
1956 ;
EB79 81EB 1957 TEB79 .W TEB81 ;Standard keyboard
EB7B C2EB 1958 .W TEBC2 ;"Shift" keyboard
EB7D 03EC 1959 .W TEC03 ;"Commodore Key" keyboard
EB7F 78EC 1960 .W TEC78 ;"Control" keyboard
1961 ;
1962 ;standard keyboard
1963 ;
EB81 140D1D 1964 TEB81 .BY $14,$0D,$1D,$88,$85,$86,$87,$11
EB89 335741 1965 .BY $33,$57,$41,$34,$5A,$53,$45,$01
EB91 355244 1966 .BY $35,$52,$44,$36,$43,$46,$54,$58
EB99 375947 1967 .BY $37,$59,$47,$38,$42,$48,$55,$56
EBA1 39494A 1968 .BY $39,$49,$4A,$30,$4D,$4B,$4F,$4E
EBA9 2B504C 1969 .BY $2B,$50,$4C,$2D,$2E,$3A,$40,$2C
EBBL 5C2A3B 1970 .BY $5C,$2A,$3B,$13,$01,$3D,$5E,$2F
EBB9 315F04 1971 .BY $31,$5F,$04,$32,$20,$02,$51,$03,$FF
1972 ;
1973 ;"Shift" keyboard table
1974 ;
1975 ;"Shift" keyboard table
1976 ;
1977 ;
1978 ;
1979 ;
1980 ;
1981 ;
1982 ;
1983 ;
1984 ;"Commodore Key" keyboard table
1985 ;
EBC2 948D9D 1975 TEBC2 .BY $94,$8D,$9D,$8C,$89,$8A,$8B,$91
EBCA 23D7C1 1976 .BY $23,$D7,$C1,$24,$DA,$D3,$C5,$01
EBD2 25D2C4 1977 .BY $25,$D2,$C4,$26,$C3,$C6,$D4,$D8
EBDA 27D9C7 1978 .BY $27,$D9,$C7,$28,$C2,$C8,$D5,$D6
EBE2 29C9CA 1979 .BY $29,$C9,$CA,$30,$CD,$CB,$CF,$CE
EBEA DBD0CC 1980 .BY $DB,$D0,$CC,$DD,$3E,$5B,$BA,$3C
EBF2 A9C05D 1981 .BY $A9,$C0,$5D,$93,$01,$3D,$DE,$3F
EBFA 215F04 1982 .BY $21,$5F,$04,$22,$A0,$02,$D1,$83,$FF
1983 ;
1984 ;"Commodore Key" keyboard table
1985 ;
EC03 948D9D 1986 TEC03 .BY $94,$8D,$9D,$8C,$89,$8A,$8B,$91
EC0B 96B3B0 1987 .BY $96,$B3,$B0,$97,$AD,$AE,$B1,$01
EC13 98B2AC 1988 .BY $98,$B2,$AC,$99,$BC,$BB,$A3,$BD
EC1B 9AB7A5 1989 .BY $9A,$B7,$A5,$9B,$BF,$B4,$B8,$BE
EC23 29A2B5 1990 .BY $29,$A2,$B5,$30,$A7,$A1,$B9,$AA
EC2B A6AFB6 1991 .BY $A6,$AF,$B6,$DC,$3E,$5B,$A4,$3C
EC33 A8DF5D 1992 .BY $A8,$DF,$5D,$93,$01,$3D,$DE,$3F
EC3B 815F04 1993 .BY $81,$5F,$04,$95,$A0,$02,$AB,$83,$FF

```

```

1995 ;check for special CHR$ values
1996 ;
EC44 C90E 1997 JEC44 CMP $OE      ;if CHR$(14) to be printed,
EC46 D007 1998 BNE JEC4F
EC48 AD18D0 1999 LDA XD018
EC4B 0902 2000 ORA $02      ;set value for unshift/shift
EC4D D009 2001 BNE BEC58      ;reset address and exit
EC4F C98E 2002 JEC4F CMP $8E      ;if CHR$(142) to be printed,
EC51 D00B 2003 BNE BEC5E
EC53 AD18D0 2004 LDA XD018
EC56 29FD 2005 AND $FD      ;set value for shift/graphics
EC58 8D18D0 2006 BEC58 STA XD018      ;reset video chip register
EC5B 4CA8E6 2007 BEC5B JMP BE6A8      ;exit
2008 ;
EC5E C908 2009 BEC5E CMP $08      ;if CHR$(8) to be printed,
EC60 D007 2010 BNE BEC69
EC62 A980 2011 LDA $80      ;set shift mode to locked
EC64 0D9102 2012 ORA X0291
EC67 3009 2013 BMI BEC72      ;and exit
EC69 C909 2014 BEC69 CMP $09      ;if CHR$(9) to be printed,
EC6A DOEE 2015 BNE BEC5B
EC6D A97F 2016 LDA $7F      ;clear shift lock flag
EC6F 2D9102 2017 AND X0291
EC72 8D9102 2018 BEC72 STA X0291      ;condition shift lock flag
EC75 4CA8E6 2019 JMP BE6A8      ;exit
2020 ;
2021 ;"Control Key" keyboard table
2022 ;
EC78 FFFFFF 2023 TEC78 .BY $FF,$FF,$FF,$FF,$FF,$FF,$FF,$FF
EC80 1C1701 2024 .BY $1C,$17,$01,$9F,$1A,$13,$05,$FF
EC88 9C1204 2025 .BY $9C,$12,$04,$1E,$03,$06,$14,$18
EC90 1F1907 2026 .BY $1F,$19,$07,$9F,$02,$08,$15,$16
EC98 12090A 2027 .BY $12,$09,$0A,$92,$0D,$0B,$0F,$0E
ECA0 FF100C 2028 .BY $FF,$10,$0C,$FF,$FF,$1B,$00,$FF
ECA8 1CF11D 2029 .BY $1C,$FF,$1D,$FF,$FF,$1F,$1E,$FF
ECB0 9006FF 2030 .BY $90,$06,$FF,$05,$FF,$FF,$11,$FF,$FF

```

```

2032 ;standard values for video chip
2033 ;
ECB9 00 2034 TECB9 .BY $00      ;+ 00, MOB 0 X position
ECBA 00 2035 .BY $00      ;+ 01, MOB 0 Y position
ECBB 00 2036 .BY $00      ;+ 02, MOB 1 X position
ECBC 00 2037 .BY $00      ;+ 03, MOB 1 Y position
ECBD 00 2038 .BY $00      ;+ 04, MOB 2 X position
ECBE 00 2039 .BY $00      ;+ 05, MOB 2 Y position
ECBF 00 2040 .BY $00      ;+ 06, MOB 3 X position
ECC0 00 2041 .BY $00      ;+ 07, MOB 3 Y position
ECC1 00 2042 .BY $00      ;+ 08, MOB 4 X position
ECC2 00 2043 .BY $00      ;+ 09, MOB 4 Y position
ECC3 00 2044 .BY $00      ;+ 0A, MOB 5 X position
ECC4 00 2045 .BY $00      ;+ 0B, MOB 5 Y position
ECC5 00 2046 .BY $00      ;+ 0C, MOB 6 X position
ECC6 00 2047 .BY $00      ;+ 0D, MOB 6 Y position
ECC7 00 2048 .BY $00      ;+ 0E, MOB 7 X position
ECC8 00 2049 .BY $00      ;+ 0F, MOB 7 Y position
ECC9 00 2050 .BY $00      ;+ 10, MSB of X position
ECCA 9B 2051 .BY $9B      ;+ 11, RC3, DEN, RSEL, Y1 and Y0 set
ECCB 37 2052 .BY $37      ;+ 12, Raster Register
ECCC 00 2053 .BY $00      ;+ 13, Light Pen X
ECCD 00 2054 .BY $00      ;+ 14, Light Pen Y
ECEE 00 2055 .BY $00      ;+ 15, MOB Enable
ECCF 08 2056 .BY $08      ;+ 16, CSEL set
ECD0 00 2057 .BY $00      ;+ 17, MOB Y expand
ECD1 14 2058 .BY $14      ;+ 18, Memory Pointers
ECD2 0F 2059 .BY $0F      ;+ 19, Interrupt Register
ECD3 00 2060 .BY $00      ;+ 1A, Enable Interrupts
ECD4 00 2061 .BY $00      ;+ 1B, MOB-Data priority
ECD5 00 2062 .BY $00      ;+ 1C, MOB Multi-Color selection
ECD6 00 2063 .BY $00      ;+ 1D, MOB X-expand
ECD7 00 2064 .BY $00      ;+ 1E, MOB-MOB collision
ECD8 00 2065 .BY $00      ;+ 1F, MOB-Data collision
ECD9 0E 2066 .BY $0E      ;+ 20, Exterior color
ECDAA 06 2067 .BY $06      ;+ 21, Background # 0 color
ECDB 01 2068 .BY $01      ;+ 22, Background # 1 color
ECDC 02 2069 .BY $02      ;+ 23, Background # .2 color
ECDD 03 2070 .BY $03      ;+ 24, Background # 3 color
ECDDE 04 2071 .BY $04      ;+ 25, MOB Multi-Color # 0
ECDF 00 2072 .BY $00      ;+ 26, MOB Multi-Color # 1
ECE0 01 2073 .BY $01      ;+ 27, MOB 0 color
ECE1 02 2074 .BY $02      ;+ 28, MOB 1 color
ECE2 03 2075 .BY $03      ;+ 29, MOB 2 color
ECE3 04 2076 .BY $04      ;+ 2A, MOB 3 color
ECE4 05 2077 .BY $05      ;+ 2B, MOB 4 color
ECE5 06 2078 .BY $06      ;+ 2C, MOB 5 color
ECE6 07 2079 .BY $07      ;+ 2D, MOB 6 color
2080 ;+2E, MOB 7 color initialized to $4C
2081 ;
2082 ;keyboard buffer entry for shift of Run/Stop key
2083 ;
ECE7 4C4F41 2084 TECE7 .BY `L,`0,`A,`D,$0D
ECEC 52554E 2085 .BY `R,`U,`N,$0D
2086 ;
2087 ;table of low bytes of screen line addresses
2088 ;
ECFO 002850 2089 TECFO .BY $00,$28,$50,$78,$A0,$C8,$F0,$18
ECFB 406890 2090 .BY $40,$68,$90,$B8,$E0,$08,$30,$58
ED00 80A8D0 2091 .BY $80,$A8,$D0,$F8,$20,$48,$70,$98,$C0

```

```

2093 ;send TALK on serial bus
2094 ;
ED09 0940 2095 SED09 ORA $40      ;add offset for TALK
EDOB 2C    2096     .BY $2C      ;skip next instruction
2097 ;
2098 ;send LISTEN on serial bus
2099 ;
EDOC 0920 2100 SEDOC ORA $20      ;add offset for LISTEN
EDOE 20A4FO 2101     JSR SFOA4    ;protect against RS-232 NMI's
ED11 48    2102 SED11 PHA        ;save code to transmit
ED12 2494  2103     BIT Z94      ;if no data is pending
ED14 100A  2104     BPL BED20
ED16 38    2105     SEC
ED17 66A3  2106     ROR ZA3      ;set EOI flag
ED19 2040ED 2107     JSR SED40    ;output byte on serial bus
EDIC 4694  2108     LSR Z94      ;clear data pending flag
ED1E 46A3  2109     LSR ZA3      ;clear EOI flag
ED20 68    2110 BED20 PLA        ;move code to transmit
ED21 8595  2111     STA Z95      ;into the output buffer
ED23 78    2112     SEI
ED24 2097EE 2113     JSR SEE97    ;set serial bus data line low
ED27 C93F  2114     CMP $3F
ED29 D003  2115     BNE BED2E    ;if not UNLISTEN
ED2B 2085EE 2116     JSR SEE85    ;set serial clock low
ED2E AD00DD 2117 BED2E LDA XDD00
ED31 0908  2118     ORA $08
ED33 8D00DD 2119     STA XDD00    ;set serial ATN line high
ED36 78    2120 SED36 SEI        ;disable IRQ
ED37 208EEE 2121     JSR SEE8E    ;set serial clock high
ED3A 2097EE 2122     JSR SEE97    ;set serial data low
ED3D 20B3EE 2123     JSR SEE83    ;delay 1 millisecond

```

```

2125 ;send a byte from Z95 on serial bus
2126 ;
ED40 78    2127 SED40 SEI      ;disable IRQ
ED41 2097EE 2128 JSR SEE97   ;set serial data low
ED44 20A9EE 2129 JSR SEEA9   ;test data level
ED47 B064   2130 BCS 8EDAD   ;if high, indicate device not present
ED49 2085EE 2131 JSR SEE85   ;set serial clock low
ED4C 24A3   2132 BIT ZA3
ED4E 100A   2133 BPL BED5A   ;if EOI flag is set
ED50 20A9EE 2134 BED50 JSR SEEA9
ED53 90FB   2135 BCC BED50   ;wait for data high
ED55 20A9EE 2136 BED55 JSR SEEA9
ED58 B0FB   2137 BCS BED55   ;wait for data low
ED5A 20A9EE 2138 BED5A JSR SEEA9
ED5D 90FB   2139 BCC BED5A   ;wait for data high (end of EOI pulse)
ED5F 208EEE 2140 JSR SEE8E   ;set output clock high
ED62 A908   2141 LDA $08
ED64 85A5   2142 STA ZA5
ED66 AD0ODD  2143 BED66 LDA XDD00
ED69 CD0ODD  2144 CMP XDD00
ED6C D0F8   2145 BNE BED66   ;wait for PA2 to steady
ED6E 0A     2146 ASL A      ;if data high not received,
ED6F 903F   2147 BCC BEDB0   ;indicate a timeout
ED71 6695   2148 ROR Z95   ;fetch bit to send
ED73 B005   2149 BCS BED7A   ;if bit is a 0,
ED75 20AOEE 2150 JSR SEEAO  ;send a 0
ED78 D003   2151 BNE BED7D   ;else send a 1
ED7A 2097EE 2152 BED7A JSR SEE97
ED7D 2085EE 2153 BED7D JSR SEE85
ED80 EA     2154 NOP
ED81 EA     2155 NOP
ED82 EA     2156 NOP
ED83 EA     2157 NOP
ED84 AD0ODD  2158 LDA XDD00
ED87 29DF   2159 AND $DF    ;set serial data line low
ED89 0910   2160 ORA $10    ;and clock high
ED8B 8D0ODD  2161 STA XDD00
ED8E C6A5   2162 DEC ZA5    ;if 8 bits not sent
ED90 D0D4   2163 BNE BED66  ;repeat
ED92 A904   2164 LDA $04
ED94 8D07DC  2165 STA XDC07
ED97 A919   2166 LDA $19    ;set TBH1 to $04xx
ED99 8D0FDC  2167 STA XDC0F
ED9C AD0DDC  2168 LDA XDC0D
ED9F AD0DDC  2169 BED9F LDA XDC0D
EDA2 2902   2170 AND $02    ;clear pending IRQ bits in ICRL
EDA4 D00A   2171 BNE BEDB0  ;if underflow on TB, indicate
EDA6 20A9EE 2172 JSR SEEA9
EDA9 B0F4   2173 BCS BED9F  ;repeat test until data line is low
EDAB 58     2174 CLI
EDAC 60     2175 RTS
                           2176 ;
EDAD A980   2177 8EDAD LDA $80  ;set Device Not Present
EDAF 2C     2178 .BY $2C    ;skip next instruction
ED80 A903   2179 8EDB0 LDA $03  ;set Timeout bits (read and write)
ED82 201CFE 2180 JEDB2 JSR SFE1C ;add bits in A to ST
ED85 58     2181 CLI
ED86 18     2182 CLC
EDB7 904A   2183 BCC 8EE03  ;set ATN low and exit

```

```

2185 ;send Secondary Address (after LISTEN) on serial bus
2186 ;
EDB9 8595 2187 SEDB9 STA Z95      ;save serial deferred character
EDBB 2036ED 2188      JSR SED36    ;send on serial bus
EDBE AD00DD 2189 SEDBE LDA XDD00
EDC1 29F7 2190      AND $F7      ;set ATN low
EDC3 8D00DD 2191      STA XDD00
EDC6 60      2192      RTS
2193 ;
2194 ;send Secondary Address (after TALK) on serial bus
2195 ;
EDC7 8595 2196 SEDC7 STA Z95      ;save serial deferred character
EDC9 2036ED 2197      JSR SED36    ;send on serial bus
EDCC 78      2198 SEDCC SEI
EDCD 20A0EE 2199      JSR SEEAO    ;set serial data high
EDDO 20BEED 2200      JSR SEDBE    ;set ATN high
EDD3 2085EE 2201      JSR SEE85    ;set serial clock low
EDD6 20A9EE 2202 BEDD6 JSR SEEA9    ;read serial clock
EDD9 30FB 2203      BMI BEDD6    ;loop until serial clock goes low
EDDB 58      2204      CLI        ;enable IRQ
EDDC 60      2205      RTS
2206 ;
2207 ;output byte on serial bus
2208 ;
EDDD 2494 2209 JEDDD BIT Z94
EDFF 3005 2210      BMI BEDE6    ;if no data buffered,
EDE1 38      2211      SEC
EDE2 6694 2212      ROR Z94      ;set serial deferred flag
EDE4 D005 2213      BNE BEDEB
EDE6 48      2214 BEDE6 PHA      ;else save character on stack
EDE7 2040ED 2215      JSR SED40    ;send deferred character on serial bus
EDEA 68      2216      PLA
EDEB 8595 2217 BEDEB STA Z95      ;save new serial deferred character
EDED 18      2218      CLC
EDEE 60      2219      RTS
2220 ;
2221 ;send TALK on serial bus
2222 ;
EDEF 78      2223 SEDEF SEI      ;disable IRQ
EDF0 208EEE 2224      JSR SEE8E    ;set serial clock low
EDF3 AD00DD 2225      LDA XDD00
EDF6 0908 2226      ORA $08      ;set serial ATN high
EDF8 8D00DD 2227      STA XDD00
EDFB A95F 2228      LDA $5F      ;set A to code for TALK
EDFD 2C      2229      .BY $2C      ;skip next instruction
2230 ;
2231 ;send UNLISTEN on serial bus
2232 ;
EDFE A93F 2233 SEDFE LDA $3F      ;set A to code for UNLISTEN
EE00 2011ED 2234      JSR SED11    ;send code in A on serial bus
EE03 20BEED 2235 BEE03 JSR SEDBE    ;set ATN low
EE06 8A      2236 SEE06 TXA
EE07 A20A 2237      LDX $0A
EE09 CA      2238 BEE09 DEX
EE0A D0FD 2239      BNE BEE09    ;pause 52 microseconds
EE0C AA      2240      TAX
EE0D 2085EE 2241      JSR SEE85    ;set serial clock low
EE10 4C97EE 2242      JMP SEE97    ;set serial data low and return

```

```

2244 ;input byte on serial bus
2245 ;
EE13 78    2246 JEE13 SEI           ;disable IRQ
EE14 A900   2247 LDA $00
EE16 85A5   2248 STA ZA5          ;clear bit count
EE18 2085EE  2249 JSR SEE85       ;set serial clock low
EE1B 20A9EE  2250 BEE1B JSR SEEA9       ;read serial clock
EE1E 10FB   2251 BPL BEE1B       ;and loop until high
EE20 A901   2252 BEE20 LDA $01
EE22 8D07DC  2253 STA XDC07      ;prime TBH1 with $0lxx
EE25 A919   2254 LDA $19
EE27 8D0FDC  2255 STA XDC0F      ;set CB1 to force load, one shot & TB1
EE2A 2097EE  2256 JSR SEE97      ;set serial data low
EE2D ADODDC  2257 LDA XDC0D      ;clear pending IRQ bits in ICR1
EE30 ADODDC  2258 BEE30 LDA XDC0D
EE33 2902   2259 AND $02
EE35 D007   2260 BNE BEE3E      ;if not underflow in TB
EE37 20A9EE  2261 JSR SEEA9      ;read serial clock and data
EE3A 30F4   2262 BMI BEE30      ;repeat if clock still low
EE3C 1018   2263 BPL BEE56      ;else go receive byte
EE3E A5A5   2264 BEE3E LDA ZA5      ;when underflow on TB and not first bit,
EE40 F005   2265 BEQ BEE47      ;set read timeout in ST
EE42 A902   2266 LDA $02
EE44 4CB2ED  2267 JMP JEDB2
                           2268 ;
EE47 20AOEE  2269 BEE47 JSR SEEAO      ;set serial data high
EE4A 2085EE  2270 JSR SEE85      ;set serial clock low
EE4D A940   2271 LDA $40
EE4F 201CFE  2272 JSR SFE1C      ;set EOI in ST
EE52 E6A5   2273 INC ZA5          ;add one to bit count
EE54 DOCA   2274 BNE BEE20      ;and repeat
EE56 A908   2275 BEE56 LDA $08
EE58 85A5   2276 STA ZA5          ;set bit count to 8
EE5A AD0ODD  2277 BEE5A LDA XDD00
EE5D CD0ODD  2278 CMP XDD00
EE60 D0F8   2279 BNE BEE5A      ;wait until PA2 is steady
EE62 0A     2280 ASL A
EE63 10F5   2281 BPL BEE5A      ;loop until clock bit rises
EE65 66A4   2282 ROR ZA4          ;add data bit to byte being read
EE67 AD0ODD  2283 BEE67 LDA XDD00
EE6A CD0ODD  2284 CMP XDD00
EE6D D0F8   2285 BNE BEE67      ;wait until PA2 is steady
EE6F 0A     2286 ASL A
EE70 30F5   2287 BMI BEE67      ;and for clock line to fall
EE72 C6A5   2288 DEC ZA5
EE74 DOE4   2289 BNE BEE5A      ;loop until 8 bits read
EE76 20AOEE  2290 JSR SEEAO      ;set serial data high
EE79 2490   2291 BIT Z90
EE7B 5003   2292 BVC BEE80      ;if EOI is high
EE7D 2006EE  2293 JSR SEE06      ;pause 52 usec, set clock and data low
EE80 A5A4   2294 BEE80 LDA ZA4      ;restore byte read
EE82 58     2295 CLI
EE83 18     2296 CLC
EE84 60     2297 RTS

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2299 ;set serial clock line low
2300 ;
EE85 AD00DO 2301 SEE85 LDA XDD00
EE88 29EF 2302 AND $EF
EE8A 8D00DD 2303 STA XDD00
EE8D 60 2304 RTS
2305 ;
2306 ;set serial clock line high
2307 ;
EE8E AD0000 2308 SEE8E LOA XDD00
EE91 0910 2309 ORA $10
EE93 8000DD 2310 STA XDD00
EE96 60 2311 RTS
2312 ;
2313 ;set serial data line low
2314 ;
EE97 AD00DD 2315 SEE97 LDA XDD00
EE9A 29DF 2316 AND $DF
EE9C 8D00DD 2317 STA XDD00
EE9F 60 2318 RTS
2319 ;
2320 ;set serial data line high
2321 ;
EEA0 AD00DD 2322 SEEAO LDA XDD00
EEA3 0920 2323 ORA $20
EEA5 8D00DD 2324 STA XDD00
EEA8 60 2325 RTS
2326 ;
2327 ;wait for PA2 to steady
2328 ;exit with data bit in C
2329 ;and clock bit in N
2330 ;
EEA9 AD00DD 2331 SEEA9 LDA XDD00
EEAC CD00DD 2332 CMP XDD00
EEAF D0F8 2333 BNE SEEA9 ;wait until PA2 is steady
EEB1 0A 2334 ASL A ;shift data into C and clock into N
EEB2 60 2335 RTS
2336 ;
2337 ;delay 1 millisecond
2338 ;
EEB3 8A 2339 SEEB3 TXA ;save A
EEB4 A2B8 2340 LDX $B8 ;initialize delay counter
EEB6 CA 2341 BEEB6 DEX
EEB7 D0FD 2342 BNE BEEB6 ;perform delay of 1 millisecond
EEB9 AA 2343 TAX ;restore A
EEBA 60 2344 RTS

```

```

2346 ;set next bit to transmit on RS-232 bus
2347 ;
EEBB A5B4 2348 SEEBB LDA ZB4      ;check pending bit count
EEBD F047 2349 BEQ BEFO6       ;if byte finished, send stop bit(s)
EEBF 303F 2350 BMI BEFO0       ;if not stop bit,
EEC1 46B6 2351 LSR ZB6        ;shift next bit to send into C
EEC3 A200 2352 LDX $00
EEC5 9001 2353 BCC BEEC8      ;X=00/FF for 0/1 to send
EEC7 CA   2354 DEX
EEC8 8A   2355 BEEC8 TXA
EEC9 45BD 2356 EOR ZBD        ;compute parity of word being sent
EECB 85BD 2357 STA ZBD
EECD C6B4 2358 DEC ZB4        ;decrement bit count
EECF F006 2359 BEQ BEED7      ;if word finished, handle parity
EED1 8A   2360 BEED1 TXA
EED2 2904 2361 AND $04
EED4 85B5 2362 STA ZB5        ;set next bit to send
EED6 60   2363 RTS
2364 ;
EED7 A920 2365 BEED7 LDA $20      ;check RS-232 Command Register
EED9 2C9402 2366 BIT X0294      ;for parity option
EEDC F014 2367 BEQ BEEF2      ;no parity
EEDE 301C 2368 BMI BEEFC      ;transmit mark or space parity
EEE0 7014 2369 BVS BEEF6      ;transmit even parity
EEE2 A5BD 2370 LDA ZBD        ;make parity odd
EEE4 D001 2371 BNE BEEE7
EEE6 CA   2372 BEEE6 DEX
EEE7 C6B4 2373 BEEE7 DEC ZB4      ;decrement bit count
EEE9 AD9302 2374 LDA X0293      ;check RS-232 Control Register
EEEC 10E3 2375 BPL BEED1      ;and branch if only one stop bit needed
EEE4 C6B4 2376 DEC ZB4        ;else decrement bit count
EEFO D0D6 2377 BNE BEED1      ;and send first of 2 stop bits
EEF2 E6B4 2378 BEEF2 INC ZB4      ;increment bit count
EEF4 DOFO 2379 BNE BEEE6
EEF6 A5BD 2380 BEEF6 LDA ZBD      ;use computed parity
EEF8 FOED 2381 BEQ BEE7        ;to set X for even parity
EEFA D0EA 2382 BNE BEEE6
EEFC 70E9 2383 BEEFC BVS BEEE7      ;transmit space parity
EEFE 50E6 2384 BVC BEEF6      ;transmit mark parity
EF00 E6B4 2385 BEFO0 INC ZB4      ;bump bit count
EF02 A2FF 2386 LDX $FF
EF04 DOCB 2387 BNE BEED1      ;go send a stop bit
EF06 AD9402 2388 BEFO6 LDA X0294      ;check RS-232 Command Register
EF09 4A   2389 LSR A
EFOA 9007 2390 BCC BEF13      ;and skip if in 3-line mode
EFOC 2C01DD 2391 BIT XDD01
EF01 101D 2392 BPL BEF2E      ;error if DSR signal missing
EF11 501E 2393 BVC BEF31      ;or CTS signal missing
EF13 A900 2394 BEF13 LDA $00
EF15 85BD 2395 STA ZBD        ;clear parity
EF17 85B5 2396 STA ZB5        ;clear next bit to send
EF19 AE9802 2397 LDX X0298      ;move number of bits to send
EF1C 86B4 2398 STX ZB4        ;to bit count
EF1E AC9D02 2399 LDY X029D      ;if RS-232 transmit buffer is not empty
EF21 CC9E02 2400 CPY X029E
EF24 F013 2401 BEQ BEF39
EF26 B1F9 2402 LDA (ZF9),Y      ;move next byte to send
EF28 85B6 2403 STA ZB6        ;to character buffer
EF2A EEE9D02 2404 INC X029D      ;bump RS-232 transmit buffer output ptr
EF2D 60   2405 RTS

```

```

2407 ;handle RS-232 errors
2408 ;
EF2E A940 2409 BEF2E LDA $40      ;add DSR signal missing error bit
EF30 2C    2410 .BY $2C          ;skip next instruction
EF31 A910 2411 BEF31 LDA $10      ;add CTS signal missing error bit
EF33 0D9702 2412 ORA X0297      ;to RS-232 Status Register
EF36 8D9702 2413 STA X0297
EF39 A901 2414 BEF39 LDA $01      ;clear TA2 IRQ mask
EF3B 8D0DDD 2415 JEF3B STA XDDOD  ;set/clear ICR2 flags depending on A
EF3E 4DA102 2416 EOR X02A1
EF41 0980 2417 ORA $80
EF43 8DA102 2418 STA X02A1      ;set ICR2 activity register
EF46 8D0DDD 2419 STA XDDOD      ;and ICR2
EF49 60    2420 RTS
2421 ;
2422 ;check control register to set word length
2423 ;
EF4A A209 2424 SEF4A LDX $09      ;start with a length of 9
EF4C A920 2425 LDA $20
EF4E 2C9302 2426 BIT X0293      ;check RS-232 Control Register
EF51 F001 2427 BEQ BEF54      ;and branch if word length is 6 or 8
EF53 CA    2428 DEX             ;else set X to 8
EF54 5002 2429 BEF54 BVC BEF58  ;if word length is 7 or 8, exit
EF56 CA    2430 DEX
EF57 CA    2431 DEX
EF58 60    2432 BEF58 RTS       ;exit with length in X
2433 ;
2434 ;add bit input on RS-232 bus to word being input
2435 ;
EF59 A6A9 2436 JEF59 LDX ZA9      ;check receiver start bit flag
EF5B D033 2437 BNE BEF90      ;if a bit is ready,
EF5D C6A8 2438 DEC ZA8         ;decrement input bit count
EF5F F036 2439 BEQ BEF97      ;if word is not complete,
EF61 300D 2440 BMI BEF70
EF63 A5A7 2441 LDA ZA7         ;use receiver input bit
EF65 45AB 2442 EOR ZAB         ;to calculate parity
EF67 85AB 2443 STA ZAB
EF69 46A7 2444 LSR ZA7        ;shift bit received
EF6B 66AA 2445 ROR ZAA         ;into byte being read
EF6D 60    2446 BEF6D RTS
2447 ;
2448 ;handle end of word for RS-232 input
2449 ;
EF6E C6A8 2450 BEF6E DEC ZA8      ;decrement input bit count
EF70 A5A7 2451 BEF70 LDA ZA7      ;check receiver input bit
EF72 F067 2452 BEQ BEFDDB     ;if something read
EF74 AD9302 2453 LDA X0293      ;use RS-232 Control Register to
EF77 0A    2454 ASL A           ;shift stop bit count flag into C
EF78 A901 2455 LDA $01
EF7A 65A8 2456 ADC ZA8         ;add possible second stop bit
EF7C DOEF 2457 BNE BEF6D      ;to input bit count and exit

```

```

        2459 ;enable byte reception
        2460 ;
EF7E A990 2461 BEF7E LDA $90
EF80 8DODDD 2462 STA XDDODD ;set Flag bit mask in ICR2
EF83 ODA102 2463 ORA X02A1 ;plus ICR2 activity register
EF86 8DA102 2464 STA X02A1 ;to form new ICR2 activity register
EF89 85A9 2465 STA ZA9 ;and receiver start bit flag
EF8B A902 2466 LDA $02
EF8D 4C3BEF 2467 JMP JEF3B ;set TB2 mask in ICR2 and exit
        2468 ;
        2469 ;receiver start bit test
        2470 ;
EF90 A5A7 2471 BEF90 LDA ZA7 ;test receiver input bit
EF92 DOEA 2472 BNE BEF7E ;if start read,
EF94 85A9 2473 STA ZA9 ;clear start bit flag
EF96 60 2474 RTS
        2475 ;
        2476 ;put received data into RS-232 receive buffer
        2477 ;
EF97 AC9B02 2478 BEF97 LDY X029B ;if RS-232 receive buffer input pointer
EF9A C8 2479 INY
EF9B CC9C02 2480 CPY X029C ;= RS-232 receive buffer output pointer
EF9E F02A 2481 BEQ BEFCA ;then receive buffer overrun error
EFA0 8C9B02 2482 STY X029B ;bump RS-232 receive buffer input ptr
EFA3 88 2483 DEY
EFA4 A5AA 2484 LDA ZAA ;fetch byte received so far in A
EFA6 AE9802 2485 LDX X0298 ;and number of bits to receive in X
EFA9 E009 2486 BEFA9 CPX $09
EFAB F004 2487 BEQ BEFB1
EFAD 4A 2488 LSR A ;right justify input byte
EFAE E8 2489 INX
EFAF D0F8 2490 BNE BEFA9
EFB1 91F7 2491 BEFB1 STA (ZF7),Y ;store received byte in receive buffer
EFB3 A920 2492 LDA $20 ;check RS-232 Command Register
EFB5 2C9402 2493 B1T X0294 ;for parity options
EFB8 FOB4 2494 BEQ BEF6E ;no parity
EFBA 30B1 2495 BMI BEF6D ;parity check disabled
EFBC A5A7 2496 LDA ZA7 ;fetch receiver parity bit
EFBE 45AB 2497 EOR ZAB ;check against calculated parity
EFC0 F003 2498 BEQ BEFC5 ;odd parity received
EFC2 70A9 2499 BVS BEF6D ;exit if even parity required
EFC4 2C 2500 .BY $2C ;skip next instruction
EFC5 50A6 2501 BEFC5 BVC BEF6D ;exit if odd parity required
EFC7 A901 2502 LDA $01 ;else indicate Parity Error
EFC9 2C 2503 .BY $2C ;skip next instruction
EFCA A904 2504 BEFCA LDA $04 ;indicate Receiver Buffer Overrun error
EFCC 2C 2505 .BY $2C ;skip next instruction
EFCF D980 2506 BEFCF LDA $80 ;indicate Break Detected error
EFCF 2:I 2507 .BY $2C ;skip next instruction
EFDO A902 2508 BEFD0 LDA $02 ;Framing error
EFD2 0D9702 2509 ORA X0297 ;plus original RS-232 Status Register
EFD5 8D9702 2510 STA X0297 ;makes new RS-232 Status Register
EFD8 4C7EEF 2511 JMP BEF7E ;enable byte reception and exit
        2512 ;
EFDB A5AA 2513 BEFDB LDA ZAA ;if byte received so far is non-zero
EFD2 D0F1 2514 BNE BEFD0 ;indicate framing error
EFD6 FOEC 2515 BEQ BEFCF ;or break detected error

```

```

2517 ;output on RS-232 device
2518 ;
EFE1 859A 2519 JEFEF1 STA Z9A      ;set output device
EFE3 AD9402 2520 LDA X0294      ;check RS-232 Command Register
EFE6 4A    2521 LSR A          ;for 3-line or X-line mode
EFE7 9029 2522 BCC BF012      ;and skip if 3-line
EFE9 A902 2523 LDA $02
EFE9 2C01DD 2524 BIT XDD01
EFEF 101D 2525 BPL BF00D      ;indicate error if DSR signal missing
EFF0 D020 2526 BNE BF012      ;exit if RTS present
EFF2 ADA102 2527 BEFFF2 LDA X02A1      ;check ICR2 activity register
EFF5 2902 2528 AND $02
EFF7 D0F9 2529 BNE BEFFF2      ;and loop until byte received
EFF9 2C01DD 2530 BEFFF9 BIT XDD01
EFFC 70FB 2531 BVS BEFFF9      ;wait for CTS signal
EFFE AD01DD 2532 LDA XDD01
FO01 0902 2533 ORA $02
FO03 814XMI :C2: STA XDD01      ;set RTS signal
FO06 2C01DD 2535 BF006 BIT XDD01
FO09 7007 2536 BVS BF012      ;exit if CTS is high
FO0B 30F9 2537 BMI BF006      ;loop if DSR is high
FO0D A940 2538 BF00D LDA $40      ;set DSR Signal Missing Error
FO0F 8D9702 2539 STA X0297      ;in RS-232 Status Register
FO12 18    2540 BF012 CLC
FO13 60    2541 RTS
2542 ;
2543 ;buffer character to output on RS-232
2544 ;
FO14 2028FO 2545 BF014 JSR SF028      ;schedule TA2 if not transmitting
FO17 AC9E02 2546 SF017 LDY X029E      ;if no room in the RS-232 buffer
FO1A C8    2547 INY
FO1B CC9D02 2548 CPY X029D
FO1E F0F4 2549 BEQ BF014      ;wait until there is room
FO20 8C9E02 2550 STY X029E      ;bump RS-232 transmit buffer output ptr
FO23 88    2551 DEY
FO24 A59E 2552 LDA Z9E      ;move buffered character
FO26 91F9 2553 STA (ZP9),Y
FO28 ADA102 2554 SF028 LDA X02A1      ;check ICR2 activity register
FO2B 4A    2555 LSR A
FO2C B01E 2556 BCS BF04C      ;if not transmitting,
FO2E A910 2557 LDA $10
FO30 8D0EDD 2558 STA XDD0E      ;force load into CRA2
FO33 AD9902 2559 LDA X0299      ;move baud rate full bit time
FO36 8D04DD 2560 STA XDD04      ;into TAL2
FO39 AD9A02 2561 LDA X029A
FO3C 8D05DD 2562 STA XDD05      ;and TAH2
FO3F A981 2563 LDA $81
FO41 203BEF 2564 JSR JEF3B      ;set TA2 mask bit in ICR2
FO44 2006EF 2565 JSR BEF06      ;perform initialization for new byte
FO47 A911 2566 LDA $11
FO49 8D0EDD 2567 STA XDD0E      ;set force load and start TA2 in CRA2
FO4C 60    2568 BF04C RTS

```

```

2570 ;initialize RS-232 input
2571 ;
F04D 8599 2572 JF04D STA Z99      ;set input device
F04F AD9402 2573 LDA X0294      ;check RS-232 Command Register
F052 4A    2574 LSR A           ;for 3-line or X-line mode
F053 9028 2575 BCC BF07D      ;and skip if 3-line
F055 2908 2576 AND $08        ;check for full/half duplex mode
F057 F024 2577 BEQ BF07D      ;and skip if full duplex
F059 A902 2578 LDA S02
F05B 2C01DD 2579 BIT XDD01      ;error if DSR signal not present
F05E 10AD 2580 BPL BF00D
F060 F022 2581 BEQ BF084
F062 ADA102 2582 BF062 LDA X02A1 ;check ICR2 activity register
F065 4A    2583 LSR A
F066 BOFA 2584 BCS BF062      ;if not transmitting,
F068 AD01DD 2585 LDA XDD01
F06B 29FD 2586 AND $FD        ;clear RTS line
F06D 8D01DD 2587 STA XDD01
F070 AD01DD 2588 BF070 LDA XDD01
F073 2904 2589 AND $04
F075 F0F9 2590 BEQ BF070      ;wait for DSR
F077 A990 2591 BF077 LDA $90
F079 18    2592 CLC
F07A 4C3BEF 2593 JMP JEF3B      ;set Flag bit mask in ICR2 and return
2594 ;
F07D ADA102 2595 BF07D LDA X02A1 ;fetch ICR2 activity register
F080 2912 2596 AND $12        ;if receiving/waiting for receiver edge,
F082 F0F3 2597 BEQ BF077      ;set Flag mask
F084 18    2598 BF084 CLC
F085 60    2599 RTS
2600 ;
2601 ;get next character from RS-232 input buffer
2602 ;
F086 AD9702 2603 SF086 LDA X0297 ;A = contents of RS-232 Status Register
F089 AC9C02 2604 LDY X029C
F08C CC9B02 2605 CPY X029B      ;if receiver buffer is empty,
F08F F008 2606 BEQ BF09C      ;set flag in RS-232 status register
F091 29F7 2607 AND $F7        ;else clear Receiver Buffer Empty flag
F093 8D9702 2608 STA X0297      ;in RS-232 Status Register
F096 B1F7 2609 LDA (ZF7),Y    ;fetch character from buffer
F098 EE9C02 2610 INC X029C      ;bump RS-232 receive buffer output ptr
F09B 60    2611 RTS
2612 ;
F09C 0908 2613 BF09C ORA $08      ;indicate Receiver Buffer Empty
F09E 8D9702 2614 STA X0297      ;in RS-232 Status Register
FOA1 A900 2615 LDA $00        ;and return with a null character
FOA3 60    2616 RTS

```

```

2618 ;protect serial/cassette routine from RS-232 NMI's
2619 ;
FOA4 48 2620 SFOA4 PHA      ;save A
FOA5 ADA102 2621 LDA X02A1  ;if no activity in ICR2
FOA8 F011 2622 BEQ BF0BB   ;exit
FOAA ADA102 2623 BFOAA LDA X02A1
FOAD 2903 2624 AND $03
FOAF DOF9 2625 BNE BFOAA  ;else wait until not sending/receiving
FOB1 A910 2626 LDA $10
FOB3 8D0DDD 2627 STA XDD0D  ;clear Flag bit mask in ICR2
FOB6 A900 2628 LDA $00
FOBB BDA102 2629 STA X02A1  ;clear ICR2 activity register
FOBB 68 2630 BF0BB PLA    ;restore A
FOBC 60 2631 RTS
2632 ;
2633 ;kernal I/O messages
2634 ;
FOBD 0D492F 2635 TFOBD .BY $0D,`I,`/,`O,` ,`E,`R,`R,`O,`R,` ,`#+$80
FOC9 0D5345 2636 TFOC9 .BY $0D,`S,`E,`A,`R,`C,`H,`I,`N,`G,` +$80
FOD4 464F52 2637 TFOD4 .BY `F,`O,`R,` +$80
FOD8 0D5052 2638 TFOD8 .BY $0D,`P,`R,`E,`S,`S,` ,`P,`L,`A,`Y,` ,`O,`N,
FOE7 544150 2639 .BY `T,`A,`P,`E+$80
FOEB 505245 2640 TFOEB .BY `P,`R,`E,`S,`S,` ,`R,`E,`C,`O,`R,`D,` ,`&,
FOFA 504C41 2641 .BY `P,`L,`A,`Y,` ,`O,`N,` ,`T,`A,`P,`E+$80
F106 0D4C4F 2642 TF106 .BY $0D,`L,`O,`A,`D,`I,`N,`G+$80
F10E 0D5341 2643 TF10E .BY $0D,`S,`A,`V,`I,`N,`G,` +$80
F116 0D5645 2644 TF116 .BY $0D,`V,`E,`R,`I,`F,`Y,`I,`N,`G+$80
F120 0D464F 2645 TF120 .BY $0D,`F,`O,`U,`N,`D,` +$80
F127 0D4F4B 2646 TF127 .BY $0D,`O,`K,$8D
2647 ;
2648 ;print kernal message indexed by Y
2649 ;
F12B 249D 2650 JF12B BIT Z9D  ;exit if not in direct mode
F12D 100D 2651 BPL BF13C
F12F B9BDF0 2652 BF12F LDA TFOBD,Y  ;fetch a character from message table
F132 0B 2653 PHP
F133 297F 2654 AND $7F  ;strip bit 7
F135 20D2FF 2655 JSR SFFD2  ;print character
F138 C8 2656 INY  ;advance index
F139 28 2657 PLP  ;if last char did not contain bit 7,
F13A 10F3 2658 BPL BF12F  ;repeat
F13C 18 2659 BF13C CLC
F13D 60 2660 RTS
2661 ;
2662 ;get a character
2663 ;
F13E A599 2664 WF13E LDA Z99  ;if input device
F140 D008 2665 BNE BF14A  ;is the keyboard
F142 A5C6 2666 LDA ZC6  ;and keyboard buffer
F144 F00F 2667 BEQ BF155  ;is not empty
F146 78 2668 SEI  ;disable IRQ
F147 4CB4E5 2669 JMP SE5B4  ;then fetch char from keyboard queue
2670 ;
F14A C902 2671 BF14A CMP $02  ;if input device is RS-232
F14C D018 2672 BNE BF166
F14E 8497 2673 SF14E STY Z97  ;save Y
F150 2086F0 2674 JSR SF086  ;get a char from RS-232 input buffer
F153 A497 2675 LDY Z97  ;restore Y
F155 1B 2676 BF155 CLC
F156 60 2677 RTS

```

```

2679 ;input a character
2680 ;
F157 A599 2681 WF157 LDA Z99      ;if the input device
F159 D00B 2682 BNE BF166       ;is the keyboard
F15B A5D3 2683 LDA ZD3       ;move position of cursor on line
F15D 85CA 2684 STA ZCA       ;to input cursor postion on line
F15F A5D6 2685 LDA ZD6       ;move cursor line number
F161 85C9 2686 STA ZC9       ;to input cursor line number
F163 4C32E6 2687 JMP JE632     ;and go input from the keyboard
                                2688 ;
F166 C903 2689 BF166 CMP $03      ;if input device is the screen
F168 D009 2690 BNE BF173       ;set screen/keyboard flag to screen
F16A 85D0 2691 STA ZD0       ;move screen line length
F16C A5D5 2692 LDA ZD5       ;to end of line pointer
F16E 85C8 2693 STA ZC8       ;and go input from the screen
F170 4C32E6 2694 JMP JE632     2695 ;
                                2696 BF173 BCS BF1AD     ;if device > 3 (serial bus), handle
F175 C902 2697 CMP $02       ;set screen/keyboard flag to screen
F177 F03F 2698 BEQ BF1B8     ;if input device is RS-232, handle
F179 8697 2699 STX Z97       ;input device is tape, save X
F17B 2099F1 2700 JSR SF199     ;fetch a byte from tape buffer
F17E B016 2701 BCS BF196     ;exit upon error
F180 48   2702 PHA          ;save byte on stack
F181 2099F1 2703 JSR SF199     ;look ahead in tape buffer
F184 B00D 2704 BCS BF193     ;and exit upon error
F186 D005 2705 BNE BF18D     ;if at end of file,
F188 A940 2706 LDA $40       ;set end of file bit
F18A 201CFE 2707 JSR SFE1C     ;in ST
F18D C6A6 2708 BF18D DEC ZA6     ;adjust tape buffer ptr back to normal
F18F A697 2709 LDX Z97       ;restore X
F191 68   2710 PLA          ;restore byte read
F192 60   2711 RTS          2712 ;
F193 AA   2713 BF193 TAX       ;set stack straight
F194 68   2714 PLA          ;restore X
F195 8A   2715 TXA          ;error exit with C set
F196 A697 2716 BF196 LDX Z97
F198 60   2717 RTS

```

```

2719 ;read a byte from the cassette buffer
2720 ;
F199 200DF8 2721 SF199 JSR SF80D      ;add 1 to buffer pointer
F19C D00B 2722     BNE BF1A9      ;if end of buffer,
F19E 2041F8 2723     JSR SF841      ;read next block
F1A1 B011 2724     BCS BF1B4      ;and exit upon error
F1A3 A900 2725     LDA $00
F1A5 85A6 2726     STA ZA6      ;reset tape buffer pointer
F1A7 FOFO 2727     BEQ SF199      ;and loop back
F1A9 B1B2 2728 BF1A9 LDA (ZB2),Y    ;fetch byte from tape buffer
F1AB 18   2729     CLC      ;indicate no error
F1AC 60   2730     RTS      ;and return
2731 ;
F1AD A590 2732 BFLAD LDA Z90      ;if ST indicates Device Not Present
F1AF F004 2733     BEQ BF1B5
F1B1 A90D 2734 BF1B1 LDA $0D      ;force a return
F1B3 18   2735 BF1B3 CLC
F1B4 60   2736 BF1B4 RTS
2737 ;
2738 ;read a byte from the serial bus
2739 ;
F1B5 4C13EE 2740 BF1B5 JMP JEE13      ;input byte from serial bus and return
2741 ;
2742 ;read a byte from the RS-232 bus
2743 ;
F1B8 204EF1 2744 BF1B8 JSR SF14E      ;get a char from RS-232 input buffer
F1BB B0F7 2745     BCS BF1B4      ;exit upon error
F1BD C900 2746     CMP $00
F1BF D0F2 2747     BNE BF1B3      ;exit if receive buffer not empty
F1C1 AD9702 2748     LDA X0297      ;if RS-232 Status Register
F1C4 2960 2749     AND $60      ;indicates DSR Missing,
F1C6 DOE9 2750     BNE BF1B1      ;force a Return
F1C8 FOEE 2751     BEQ BF1B8      ;else repeat

```

```

2753 ;output a character
2754 ;
F1CA 48    2755 WF1CA PHA      ;save character on stack
F1CB A59A   2756 LDA Z9A      ;if output device
F1CD C903   2757 CMP $03     ;is the screen
F1CF D004   2758 BNE BF1D5
F1D1 68    2759 PLA        ;restore character
F1D2 4C16E7 2760 JMP SE716   ;and output to screen
2761 ;
F1D5 9004   2762 BF1D5 BCC BF1DB ;if output device > 3
F1D7 68    2763 PLA        ;restore character
F1D8 4CDDED 2764 JMP JEDDD   ;and output to serial bus
2765 ;
F1DB 4A    2766 BF1DB LSR A   ;set C to 1 for cassette
F1DC 68    2767 PLA        ;move character to output
F1DD 859E   2768 SF1DD STA Z9E ;to temporary storage
F1DF 8A    2769 TXA
F1E0 48    2770 PHA
F1E1 98    2771 TYA
F1E2 48    2772 PHA      ;save XY on stack
F1E3 9023   2773 BCC BF208   ;if output device is cassette
F1E5 200DF8  2774 JSR SF80D   ;add one to tape buffer index
F1E8 D00E   2775 BNE BF1F8   ;if buffer is full, (192 bytes)
F1EA 2064F8  2776 JSR SF864   ;write block to cassette
F1ED B00E   2777 BCS BF1FD   ;and exit upon error
F1EF A902   2778 LDA $02     ;use use Data code
F1F1 A000   2779 LDY $00
F1F3 91B2   2780 STA (ZB2),Y ;in beginning of next tape buffer
F1F5 C8    2781 INY
F1F6 84A6   2782 STY ZA6     ;initialize tape buffer pointer
F1F8 A59E   2783 BF1F8 LDA Z9E ;move character to output
F1FA 91B2   2784 STA (ZB2),Y ;into the tape buffer
F1FC 18    2785 JF1FC CLC   ;clear error flag
F1FD 68    2786 BF1FD PLA
F1FE A8    2787 TAY
F1FF 68    2788 PLA
F200 AA    2789 TAX       ;restore XY
F201 A59E   2790 LDA Z9E     ;restore character just output
F203 9002   2791 BCC BF207   ;exit if no errors
F205 A900   2792 LDA $00     ;else return with A=0
F207 60    2793 BF207 RTS
2794 ;
F208 2017F0  2795 BF208 JSR SF017 ;out a character to RS-232 channel
F20B 4CFCFL  2796 JMP JF1FC ;and exit

```

```

2798 ;set input device
2799 ;
F20E 200FF3 2800 WF20E JSR SF30F ;check X against logical file table
F211 F003 2801 BEQ BF216 ;if not matched,
F213 4C01F7 2802 JMP JF701 ;indicate File Not Open
2803 ;
F216 201FF3 2804 BF216 JSR SF31F ;set logical file, device and sec. adr
F219 A5BA 2805 LDA ZBA ;if device is keyboard,
F21B F016 2806 BEQ BF233 ;exit
F21D C903 2807 CMP $03 ;if device is screen,
F21F F012 2808 BEQ BF233 ;exit
F221 B014 2809 BCS BF237 ;handle if device is serial bus (> 3)
F223 C902 2810 CMP $02
F225 D003 2811 BNE BF22A ;if device is RS-232,
F227 4C4DF0 2812 JMP JF04D ;initialize RS-232 input
2813 ;
F22A A6B9 2814 BF22A LDX ZB9 ;if input device is tape and sec. adr
F22C E060 2815 CPX $60 ;indicates that this is an input file
F22E F003 2816 BEQ BF233 ;great,
F230 4COAF7 2817 JMP JF70A ;else indicate Not Input File Error
2818 ;
F233 8599 2819 BF233 STA Z99 ;set input device
F235 18 2820 CLC ;clear error flag
F236 60 2821 RTS
2822 ;
2823 ;set serial bus input device
2824 ;
F237 AA 2825 BF237 TAX
F238 2009ED 2826 JSR SED09 ;send TALK on serial bus
F23B A5B9 2827 LDA ZB9 ;if secondary address specified,
F23D 1006 2828 BPL BF245 ;send it
F23F 20CCED 2829 JSR SEDCC ;else send dummy secondary address
F242 4C48F2 2830 JMP JF248
2831 ;
F245 20C7ED 2832 BF245 JSR SEDC7 ;send secondard addr (after TALK)
F248 8A 2833 JF248 TXA
F249 2490 2834 BIT Z90
F24B 10E6 2835 BPL BF233 ;if ST shows device present, exit
F24D 4C07F7 2836 JMP JF707 ;else indicate error

```

```

2838 ;set output device
2839 ;
F250 200FF3 2840 WF250 JSR SF30F      ;check X against logical file table
F253 F003   2841 BEQ BF258
F255 4C01F7 2842 JMP JF701      ;File Not Open Error if not found
2843 ;
F258 201FF3 2844 BF258 JSR SF31F      ;set logical file, device and sec. adr
F25B A5BA   2845 LDA ZBA      ;if current device
F25D D003   2846 BNE BF262      ;indicates an input file
F25F 4C0DF7 2847 BF25F JMP JF70D      ;error Not Output File
2848 ;
F262 C903   2849 BF262 CMP $03      ;if device is the screen
F264 F00F   2850 BEQ BF275
F266 B011   2851 BCS BF279      ;if serial bus device, handle
F268 C902   2852 CMP $02      ;if device is RS-232
F26A D003   2853 BNE BF26F
F26C 4CE1EF 2854 JMP JEFE1      ;initialize RS-232 output
2855 ;
F26F A6B9   2856 BF26F LDX ZB9      ;if secondary address
F271 E060   2857 CPX $60      ;indicates an input file
F273 F0EA   2858 BEQ BF25F      ;Not Output File Error
F275 859A   2859 BF275 STA Z9A      Xstore output device
F277 18     2860 CLC      ;clear error indication
F278 60     2861 RTS
2862 ;
2863 ;set serial bus output device
2864 ;
F279 AA     2865 BF279 TAX
F27A 200CED 2866 JSR SEDOC      ;send LISTEN on serial bus
F27D A5B9   2867 LDA ZB9      ;if secondary address specified,
F27F 1005   2868 BPL BF286      ;send it
F281 20BEED 2869 JSR SEDBE      ;else send dummy secondary address
F284 D003   2870 BNE BF289      ;skip next instruction
F286 20B9ED 2871 BF286 JSR SEDB9      ;send secondary addr after LISTEN
F289 8A     2872 BF289 TXA
F28A 2490   2873 BIT Z90      ;check ST
F28C 10E7   2874 BPL BF275      ;and set output device if no errors
F28E 4C07F7 2875 JMP JF707      ;else indicate Device Not Present Error

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```

2877 ;CLOSE a file
2878 ;
F291 2014F3 2879 WF291 JSR SF314 ;check A against logical file table
F294 F002 2880 BEQ BF298 ;continue if found
F296 18 2881 CLC ;else exit
F297 60 2882 RTS
2883 ;
F298 201FF3 2884 BF298 JSR SF31F ;set logical file, device and sec. adr
F29B 8A 2885 TXA
F29C 48 2886 PHA ;save file index
F29D A5BA 2887 LDA ZBA ;if current device is keyboard
F29F F050 2888 BEQ BF2F1
F2A1 C903 2889 CMP $03
F2A3 F04C 2890 BEQ BF2F1 ;or screen, skip to end
F2A5 B047 2891 BCS BF2EE ;if serial bus device (> 3), handle
F2A7 C902 2892 CMP $02
F2A9 D01D 2893 BNE BF2C8 ;if RS-232 device,
F2AB 68 2894 PLA ;restore file index
F2AC 20F2F2 2895 JSR SF2F2 ;re-organize file tables
F2AF 2083F4 2896 JSR SF483 ;re-initialize CIA2
F2B2 2027FE 2897 JSR SFE27 ;read top of memory into XY
F2B5 A5F8 2898 LDA ZF8 ;if high byte of RS-232 receive buffer
F2B7 F001 2899 BEQ BF2BA ;base address is not 0,
F2B9 C8 2900 INY ;add 1 to high byte of top of memory
F2BA A5FA 2901 BF2BA LDA ZFA ;if high byte of RS-232 transmit buffer
F2BC F001 2902 BEQ BF2BF ;base address is not 0
F2BE C8 2903 INY ;add 1 to high byte of top of memory
F2BF A900 2904 BF2BF LDA $00 ;clear high byte of RS-232
F2C1 85F8 2905 STA ZF8 ;receive and transmit buffer
F2C3 85FA 2906 STA ZFA ;base addresses
F2C5 4C7DF4 2907 JMP JF47D ;set new top of memory from XY

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2909 ;close cassette device
2910 ;
F2C8 A5B9 2911 BF2C8 LDA ZB9      ;if secondary address
F2CA 290F 2912 AND $0F          ;indicates an input file,
F2CC F023 2913 BEQ BF2F1        ;skip following
F2CE 20D0F7 2914 JSR SF7D0        ;else get tape buffer pointer in XY
F2D1 A900 2915 LDA $00
F2D3 38   2916 SEC
F2D4 20DDF1 2917 JSR SF1DD       ;close file with a $00
F2D7 2064F8 2918 JSR SF864       ;write last block to cassette
F2DA 9004 2919 BCC BF2E0
F2DC 68   2920 PLA            ;and return with C set upon error
F2DD A900 2921 LDA $00
F2DF 60   2922 RTS
2923 ;
F2E0 A5B9 2924 BF2E0 LDA ZB9      ;if secondary address indicates that
F2E2 C962 2925 CMP $62          ;EOT marker to be written,
F2E4 D00B 2926 BNE BF2F1
F2E6 A905 2927 LDA $05
F2E8 206AF7 2928 JSR SF76A       ;write special block to tape with EOT
F2EB 4CF1F2 2929 JMP BF2F1       ;then re-organize file tables
2930 ;
2931 ;close serial bus device
2932 ;
F2EE 2042F6 2933 BF2EE JSR SF642     ;close serial bus device
F2F1 68   2934 BF2F1 PLA          ;restore file index
2935 ;
2936 ;re-organize file tables
2937 ;
F2F2 AA   2938 SF2F2 TAX
F2F3 C698 2939 DEC Z98          ;decrement # files open
F2F5 E498 2940 CPX Z98
F2F7 F014 2941 BEQ BF30D        ;exit if all files closed
F2F9 A498 2942 LDY Z98
F2FB B95902 2943 LDA X0259,Y    ;else move parameters of last entry
F2FE 9D5902 2944 STA X0259,X    ;(file, device and secondary address)
F301 B96302 2945 LDA X0263,Y    ;to slot of file being closed
F304 9D6302 2946 STA X0263,X    ;this removes file being closed
F307 B96D02 2947 LDA X026D,Y
F30A 9D6D02 2948 STA X026D,X
F30D 18   2949 BF30D CLC
F30E 60   2950 RTS

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```

2952 ;check X against logical file table
2953 ;
F30F A900 2954 SF30F LDA $00
F311 8590 2955 STA Z90      ;clear status word ST
F313 8A    2956 TXA
F314 A698  2957 SF314 LDX Z98   ;use # of files open to begin search
F316 CA    2958 BF316 DEX
F317 3015  2959 BMI BF32E   ;exit if file not found
F319 DD5902 2960 CMP X0259,X
F31C D0F8   2961 BNE BF316   ;repeat if not matched
F31E 60    2962 RTS
2963 ;
2964 ;set file parameters depending on X
2965 ;
F31F BD5902 2966 SF31F LDA X0259,X
F322 85B8   2967 STA Z88     ;set current logical file
F324 BD6302 2968 LDA X0263,X
F327 85BA   2969 STA Z8A     ;set current device
F329 BD6D02 2970 LDA X026D,X
F32C 85B9   2971 STA ZB9     ;set current secondary address
F32E 60    2972 BF32E RTS
2973 ;
2974 ;close all files
2975 ;
F32F A900   2976 WF32F LDA $00
F331 8598   2977 STA Z98     ;clear number of files open
2978 ;
2979 ;restore I/O to default devices
2980 ;
F333 A203   2981 WF333 LDX $03
F335 E49A   2982 CPX Z9A     ;if output device is not the serial bus
F337 B003   2983 BCS BF33C
F339 20FED  2984 JSR SEDFE  ;send UNLISTEN on serial bus
F33C E499   2985 BF33C CPX Z99   ;if input device is not on serial bus,
F33E B003   2986 BCS BF343
F340 20EFED 2987 JSR SEDEF  ;send TALK on serial bus
F343 869A   2988 BF343 STX Z9A   ;set output device to screen
F345 A900   2989 LDA $00
F347 8599   2990 STA Z99     ;set input device to keyboard
F349 60    2991 RTS

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        2993 ;OPEN a file
        2994 ;
F34A A6B8 2995 WF34A LDX ZB8      ;if current logical file is 0
F34C D003 2996     BNE BF351
F34E 4COAF7 2997     JMP JF70A      ;indicate Not Input File Error
        2998 ;
F351 200FF3 2999 BF351 JSR SF30F    ;check X against logical file table
F354 D003 3000     BNE BF359
F356 4CFEF6 3001     JMP JF6FE      ;File Open Error
        3002 ;
F359 A698 3003 BF359 LDX Z98      ;if # files open is 10 or more,
F35B E00A 3004     CPX $0A
F35D 9003 3005     BCC BF362
F35F 4CFBF6 3006     JMP JF6FB      ;Too Many Files Error
        3007 ;
F362 E698 3008 BF362 INC Z98      ;add 1 to # files open
F364 A5B8 3009     LDA ZB8
F366 9D5902 3010 STA X0259,X      ;to end of table of logical files open
F369 A5B9 3011     LDA ZB9
F36B 0960 3012 ORA $60
F36D 85B9 3013 STA ZB9
F36F 9D6D02 3014 STA X026D,X      ;add secondary address
F372 A5BA 3015     LDA ZBA
F374 9D6302 3016 STA X0263,X      ;to current device table
F377 F05A 3017 BEQ BF3D3        ;and exit if device is keyboard
F379 C903 3018 CMP $03
F37B F056 3019 BEQ BF3D3        ;or screen
F37D 9005 3020 BCC BF384
F37F 20D5F3 3021 JSR SF3D5      ;for serial device (> 3), perform open
F382 904F 3022 BCC BF3D3        ;JMP
F384 C902 3023 BF384 CMP $02
F386 D003 3024 BNE BF38B
F388 4C09F4 3025 JMP JF409      ;for RS-232 device, perform open
        3026 ;
        3027 ;open for cassette device
        3028 ;
F38B 20D0F7 3029 BF38B JSR SF7D0    ;get tape buffer address in XY
F38E B003 3030 BCS BF393
F390 4C13F7 3031 JMP JF713      ;indicate Illegal Device #
        3032 ;
F393 A5B9 3033 BF393 LDA ZB9      ;get current secondary address
F395 290F 3034 AND $0F
F397 D01F 3035 BNE BF3B8
F399 2017F8 3036 JSR SF817      ;skip if open for output
F39C B036 3037 BCS BF3D4
F39E 20AFF5 3038 JSR SF5AF      ;handle msgs for cassette read
F3A1 A5B7 3039 LDA ZB7
F3A3 F00A 3040 BEQ BF3AF
F3A5 20EAF7 3041 JSR SF7EA      ;exit upon error
F3A8 9018 3042 BCC BF3C2
F3AA F028 3043 BEQ BF3D4
F3AC 4C04F7 3044 BF3AC JMP JF704    ;handle messages for load
        3045 ;
F3AF 202CF7 3046 BF3AF JSR SF72C    ;get # characters in file name
F3B2 F020 3047 BEQ BF3D4
F3B4 900C 3048 BCC BF3C2
F3B6 B0F4 3049 BCS BF3AC      ;since no name, get next tape data
                                ;if name present, search tape for file
                                ;if not matched
                                ;and not end of tape,
                                ;File Not Found Error
                                ;exit if end of tape
                                ;if no errors, continue
                                ;else indicate File Not Found Error

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    3051 ;open cassette for output
    3052 ;
F3B8 2038F8 3053 BF3B8 JSR SF838      ;handle msgs for cassette write
F3BB B017 3054 BCS BF3D4      ;exit upon error
F3BD A904 3055 LDA $04
F3BF 206AF7 3056 JSR SF76A      ;write block with Data Header code
F3C2 A9BF 3057 BF3C2 LDA $BF      ;initialize buffer index
F3C4 A4B9 3058 LDY ZB9      ;check secondary address
F3C6 C060 3059 CPY $60      ;if tape opened for output
F3C8 F007 3060 BEQ BF3D1
F3CA A000 3061 LDY $00
F3CC A902 3062 LDA $02      ;put code for Data Block
F3CE 91B2 3063 STA (ZB2),Y      ;into first byte of buffer
F3D0 98 3064 TYA
F3D1 85A6 3065 BF3D1 STA ZA6      ;initialize tape buffer pointer
F3D3 18 3066 BF3D3 CLC
F3D4 60 3067 BF3D4 RTS
    3068 ;
    3069 ;open for serial bus devices (device > 3)
    3070 ;
F3D5 A5B9 3071 SF3D5 LDA ZB9      ;if current secondary address invalid,
F3D7 30FA 3072 BMI BF3D3      ;exit
F3D9 A4B7 3073 LDY ZB7      ;if name not present,
F3DB F0F6 3074 BEQ BF3D3      ;exit
F3DD A900 3075 LDA $00
F3DF 8590 3076 STA Z90      ;else clear ST
F3E1 A5BA 3077 LDA ZBA      ;set current device
F3E3 200CED 3078 JSR SEDOC      ;send UNLISTEN on serial bus
F3E6 A5B9 3079 LDA ZB9      ;send current secondary address
F3E8 09FO 3080 ORA $FO      ;plus offset
F3EA 2089ED 3081 JSR SEDB9      ;on serial bus
F3ED A590 3082 LDA Z90      ;check ST
F3EF 1005 3083 BPL BF3F6      ;if Device Not Present,
F3F1 68 3084 PLA      ;delete own return address
F3F2 68 3085 PLA
F3F3 4C07F7 3086 JMP JF707      ;indicate Device Not Present
    3087 ;
F3F6 A5B7 3088 BF3F6 LDA ZB7      ;if file name present
F3F8 F00C 3089 BEQ BF406
F3FA A000 3090 LDY $00      ;initialize index
F3FC B1BB 3091 BF3FC LDA (ZBB),Y
F3FE 20DDED 3092 JSR JEDDD      ;send file name on serial bus
F401 C8 3093 INY
F402 C4B7 3094 CPY ZB7
F404 D0F6 3095 BNE BF3FC      ;repeat for all characters of file name
F406 4C54F6 3096 BF406 JMP JF654      ;send UNLISTEN on serial bus and exit

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3098 ;OPEN RS-232 device
3099 ;
F409 2083F4 3100 JF409 JSR SF483 ;initialize CIA2
F40C 8C9702 3101 STY X0297 ;clear RS-232 Status Register
F40F C4B7 3102 BF40F CPY ZB7 . ;if pseudo file name present,
F411 F00A 3103 BEQ BF41D
F413 B1BB 3104 LDA (ZBB),Y ;set Control & Command registers
F415 999302 3105 STA X0293,Y ;and possible non-standard baud rate
F418 C8 3106 INY
F419 C004 3107 CPY $04
F41B D0F2 3108 BNE BF40F
F41D 204AEF 3109 BF41D JSR SEF4A ;fetch word length and move to
F420 8E9802 3110 STX X0298 ;number of bits to send
F423 AD9302 3111 LDA X0293 ;check RS-232 Control Register
F426 290F 3112 AND $0F
F428 F01C 3113 BEQ BF446 ;if standard baud rate specified,
F42A OA 3114 ASL A ;calculate index into table
F42B AA 3115 TAX
F42C ADA602 3116 LDA X02A6 ;if US machine
F42F D009 3117 BNE BF43A
F431 BCC1FE 3118 LDY TFEC2-1,X ;use US table of baud rate
F434 BDC0FE 3119 LDA TFEC2-2,X
F437 4C40F4 3120 JMP JF440 ;go set baud rate
3121 ;
F43A BCEBE4 3122 BF43A LDY TE4EC-1,X ;use Intl table of baud rate factors
F43D BDEAE4 3123 LDA TE4EC-2,X ;to fetch baud rate factor
F440 8C9602 3124 JF440 STY X0296 ;set baud rate factor
F443 8D9502 3125 STA X0295 ;low byte also
F446 AD9502 3126 BF446 LDA X0295
F449 OA 3127 ASL A
F44A 202EFF 3128 JSR SFF2E ;continue to compute baud rate
F44D AD9402 3129 LDA X0294 ;check RS-232 Command Register
F450 4A 3130 LSR A ;for 3-line or X-line mode
F451 9009 3131 BCC BF45C ;and skip if in 3-line mode
F453 AD01DD 3132 LDA XDD01
F456 OA 3133 ASL A
F457 B003 3134 BCS BF45C ;continue if DSR present, else
F459 200DF0 3135 JSR BF00D ;DSR Signal Missing Error
3136 ;
F45C AD9B02 3137 BF45C LDA X029B ;move RS-232 receive buffer input ptr
F45F 8D9C02 3138 STA X029C ;to RS-232 receive buffer output ptr
F462 AD9E02 3139 LDA X029E ;move RS-232 transmit buffer input ptr
F465 8D9D02 3140 STA X029D ;to RS-232 transmit buffer output ptr
F468 2027FE 3141 JSR SFE27 ;fetch top of memory in XY
F46B A5F8 3142 LDA ZF8 ;if high byte of RS-232 receive buffer
F46D D005 3143 BNE BF474 ;base address not initialized yet,
F46F 88 3144 DEY ;subtract 1 from top of memory address
F470 84F8 3145 STY ZF8 ;use top of memory address to
F472 86F7 3146 STX ZF7 ;initialize receive buffer base address
F474 A5FA' 3147 BF474 LDA ZFA ;same operation for transmit buffer
F476 D005 3148 BNE JF47D ;base address
F478 88 3149 DEY
F479 84FA 3150 STY ZFA
F47B 86F9 3151 STX ZF9
F47D 38 3152 JF47D SEC
F47E A9F0 3153 LDA $FO
F480 4C2DFF 3154 JMP JFE2D ;reset top of memory pointers from XY

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        3156 ;initialize CIA2
        3157 ;
F483 A97F 3158 SF483 LDA $7F
F485 8D0DDD 3159 STA XDD0D ;clear any pending IRQ's in ICR2
F488 A906 3160 LDA $06
F48A 8D03DD 3161 STA XDD03 ;PB2 bits 1 and 2 as outputs
F48D 8D01DD 3162 STA XDD01 ;set DTR and RTS high
F490 A904 3163 LDA $04
F492 0D00DD 3164 ORA XDD00
F495 8D00DD 3165 STA XDD00 ;set RS-232 output to high (idle)
F498 A000 3166 LDY $00
F49A 8CA102 3167 STY X02A1 ;clear ICR2 activity register
F49D 60 3168 RTS
        3169 ;
        3170 ;load RAM from a device
        3171 ;
F49E 86C3 3172 JF49E STX ZC3 ;set destination address from XY
F4A0 84C4 3173 STY ZC4
F4A2 6C3003 3174 JMP (X0330) ;load RAM (normally F4A5)
        3175 ;
        3176 ;standard load RAM entry
        3177 ;
F4A5 8593 3178 WF4A5 STA Z93 ;set load/verify switch to load
F4A7 A900 3179 LDA $00
F4A9 8590 3180 STA Z90 ;clear ST
F4AB A5BA 3181 LDA ZBA ;if current device is the keyboard (0)
F4AD D003 3182 BNE BF4B2
F4AF 4C13F7 3183 BF4AF JMP JF713 ;indicate Illegal Device # Error
        3184 ;
F4B2 C903 3185 BF4B2 CMP $03 ;if current device is the screen
F4B4 F0F9 3186 BEQ BF4AF ;indicate error
F4B6 907B 3187 BCC BF533 ;if not serial bus device
F4B8 A4B7 3188 LDY ZB7 ;and if no file name,
F4BA D003 3189 BNE BF4BF
F4BC 4C10F7 3190 JMP JF710 ;indicate File Name Missing Error
        3191 ;
F4RF A6B9 3192 BF4BF LDX ZB9 ;move X to secondary address
F4C1 20AFF5 3193 JSR SF5AF ;handle load messages
F4C4 A960 3194 LDA $60 ;set current secondary address
F4C6 85B9 3195 STA ZB9
F4C8 20D5F3 3196 JSR SF3D5 ;perform open of serial bus device
F4CB A5BA 3197 LDA ZBA ;let A = current device
F4CD 2009ED 3198 JSR SED09 ;send TALK on serial bus
F4D0 A5B9 3199 LDA ZB9 ;fetch secondary address
F4D2 20C7ED 3200 JSR SEDC7 ;and send on serial bus
F4D5 2013EE 3201 JSR JEE13 ;input a byte on serial bus
F4D8 85AE 3202 STA ZAE ;set I/O end address
F4DA A590 3203 LDA Z90
F4DC 4A 3204 LSR A
F4DD 4A 3205 LSR A
F4LE B050 3206 BCS BF530 ;if ST doesn't indicate a timeout (read)
F4EO 2013EE 3207 JSR JEE13 ;input a byte on serial bus
F4E3 85AF 3208 STA ZAF ;set high byte of end address
F4E5 8A 3209 TXA
F4E6 D008 3210 BNE BF4F0 ;if EOI is not low,
F4E8 A5C3 3211 LDA ZC3 ;use destination address
F4EA 85AE 3212 STA ZAE ;as end address
F4EC A5C4 3213 LDA ZC4 ;ditto for high byte
F4EE 85AF 3214 STA ZAF
F4FO 20D2F5 3215 BF4FO JSR SF5D2 ;print LOAD or VERIFY

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F4F3 A9FD 3216 BF4F3 LDA $FD      ;clear timeout (read) bit
F4F5 2590 3217 AND Z90          ;in ST
F4F7 8590 3218 STA Z90
F4F9 20E1FF 3219 JSR SFFE1      ;check for Stop key
F4FC D003 3220 BNE BF501      ;if depressed
F4FE 4C33F6 3221 JMP JF633      ;abort load
            3222 ;
F501 2013EE 3223 BF501 JSR JEE13  ;input a byte on serial bus
F504 AA   3224 TAX
F505 A590 3225 LDA Z90          ;if Timeout (read) set in ST
F507 4A   3226 LSR A
F508 4A   3227 LSR A
F509 BOE8 3228 BCS BF4F3      ;abort load
F50B 8A   3229 TXA
F50C A493 3230 LDY Z93          ;if in verify mode
F50E F00C 3231 BEQ BF51C
F510 A000 3232 LDY $00
F512 D1AE 3233 CMP (ZAE),Y  ;compare byte read to memory
F514 F008 3234 BEQ BF51E
F516 A910 3235 LDA $10
F518 201CFE 3236 JSR SFE1C    ;and set verify error upon mismatch
F51B 2C   3237 .BY $2C        ;skip next instruction
F51C 91AE 3238 BF51C STA (ZAE),Y ;load byte to memory
F51E E6AE 3239 BF51E INC ZAE   ;bump load address
F520 D002 3240 BNE BF524
F522 E6AF 3241 INC ZAF
F524 2490 3242 BF524 BIT Z90   ;if not end of file,
F526 50CB 3243 BVC BF4F3      ;repeat
F528 20EFED 3244 JSR SEDEF    ;else sent TALK on serial bus
F52B 2042F6 3245 JSR SF642    ;close serial bus
F52E 9079 3246 BCC BF5A9     ;and exit
F530 4C04F7 3247 BF530 JMP JF704 ;indicate File Not Found Error
            3248 ;
F533 4A   3249 BF533 LSR A      ;if input device is not 1 (cassette)
F534 B003 3250 BCS BF539
F536 4C13F7 3251 JMP JF713      ;indicate Illegal Device #
            3252 ;
F539 20D0F7 3253 BF539 JSR SF7D0 ;fetch tape buffer pointer
F53C B003 3254 BCS BF541
F53E 4C13F7 3255 JMP JF713      ;if invalid, indicate Illegal Device #
            3256 ;
F541 2017F8 3257 BF541 JSR SF817 ;display msgs snd test buttons for read
F544 B068 3258 BCS BF5AE
F546 20AFF5 3259 JSR SF5AF
F549 A5B7 3260 BF549 LDA ZB7   ;handle load messages
F54B F009 3261 BEQ BF556      ;if file name present
F54D 20EAFF7 3262 JSR SF7EA    ;search tape for file name
F550 900B 3263 BCC BF55D      ;if no errors, continue
F552 F05A 3264 BEQ BF5AE
F554 B0DA 3265 BCS BF530      ;exit if end of tape
F556 202CF7 3266 BF556 JSR SF72C ;error if not found
F559 F053 3267 BEQ BF5AE      ;since no file name, get.next tape hdr
F55B B0D3 3268 BCS BF530      ;exit if end of tape found
F55D A590 3269 BF55D LDA Z90 ;indicste File Not Found Error
F55F 2910 3270 AND $10       ;check ST for unrecoverable resd error
F561 38   3271 SEC
F562 D04A 3272 BNE BF5AE      ;and exit if so
F564 E001 3273 CPX $01        ;if not Program Header
F566 F011 3274 BEQ BF579
F568 E003 3275 CPX $03

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F56A D0DD	3276	BNE BF549	
F56C A001	3277	BF56C LDY \$01	
F56E B1B2	3278	LDA (ZB2),Y	
F570 85C3	3279	STA ZC3	;reset load address from tape buffer
F572 C8	3280	INY	
F573 B1B2	3281	LDA (ZB2),Y	;high byte also
F575 85C4	3282	STA ZC4	
F577 B004	3283	BCS BF57D	
F579 A5B9	3284	BF579 LDA ZB9	
F57B DOEF	3285	BNE BF56C	
F57D A003	3286	BF57D LDY \$03	;index low byte of end address
F57F B1B2	3287	LDA (ZB2),Y	
F581 A001	3288	LDY \$01	
F583 F1B2	3289	SBC (ZB2),Y	;compute length of block to load
F585 AA	3290	TAX	
F586 A004	3291	LDY \$04	
F588 B1B2	3292	LDA (ZB2),Y	
F58A A002	3293	LDY \$02	
F58C F1B2	3294	SBC (ZB2),Y	
F58E A8	3295	TAY	
F58F 18	3296	CLC	
F590 8A	3297	TXA	
F591 65C3	3298	ADC ZC3	
F593 85AE	3299	STA ZAE	;and set end address of I/O area
F595 98	3300	TYA	
F596 65C4	3301	ADC ZC4	
F598 85AF	3302	STA ZAF	
F59A A5C3	3303	LDA ZC3	
F59C 85C1	3304	STA ZC1	;set tape load address
F59E A5C4	3305	LDA ZC4	
F5A0 85C2	3306	STA ZC2	
F5A2 20D2F5	3307	JSR SF5D2	;display load messages
F5A5 204AF8	3308	JSR SF84A	;load from cassette
F5A8 24	3309	.BY \$24	;skip next instruction
F5A9 18	3310	BF5A9 CLC	;clear error flag
F5AA A6AE	3311	LDX ZAE	;exit with end address in XY
F5AC A4AF	3312	LDY ZAF	
F5AE 60	3313	BF5AE RTS	

```

3315 ;handle messages for a load operation
3316 ;
F5AF A59D 3317 SF5AF LDA Z9D
F5B1 101E 3318 BPL BF5D1      ;exit if in Run mode
F5B3 A00C 3319 LDY $0C
F5B5 202FF1 3320 JSR BF12F    ;print SEARCHING
F5B8 A5B7 3321 LDA ZB7      ;if file name is present,
F5BA F015 3322 BEQ BF5D1
F5BC A017 3323 LDY $17
F5BE 202FF1 3324 JSR BF12F    ;print FOR
F5C1 A4B7 3325 JF5C1 LDY ZB7      ;if file name is present
F5C3 F00C 3326 BEQ BF5D1
F5C5 A000 3327 LDY $00
F5C7 B1BB 3328 BF5C7 LDA (ZBB),Y ;print file name
F5C9 20D2FF 3329 JSR SFFD2
F5CC C8 3330 INY
F5CD C4B7 3331 CPY ZB7
F5CF D0F6 3332 BNE BF5C7    ;repeat for all characters in name
F5D1 60 3333 BF5D1 RTS
3334 ;
3335 ;handle Load/Verify message
3336 ;
F5D2 A049 3337 SF5D2 LDY $49      ;assume Load
F5D4 A593 3338 LDA Z93
F5D6 F002 3339 BEQ BF5DA
F5D8 A059 3340 LDY $59      ;change to Verify if flag is non-zero
F5DA 4C2BF1 3341 BF5DA JMP JF12B ;display message and return

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```

3343 ;Save RAM to a device
3344 ;
F5DD 86AE 3345 JF5DD STX ZAE      ;set end of I/O area from XY
F5DF 84AF 3346 STY ZAF
F5E1 AA   3347 TAX      ;A = index to start address
F5E2 B500 3348 LDA Z00,X
F5E4 85C1 3349 STA ZC1      ;move start address to ZC1/2
F5E6 B501 3350 LDA Z01,X
F5E8 85C2 3351 STA ZC2
F5EA 6C3203 3352 JMP (X0332) ;perform Save (normally F5ED)
3353 ;
3354 ;standard save RAM entry
3355 ;
F5ED A5BA 3356 WF5ED LDA ZBA      ;if current device is keyboard (0)
F5EF D003 3357 BNE BF5F4
F5F1 4C13F7 3358 BF5F1 JMP JF713 ;indicate Illegal Device #
3359 ;
F5F4 C903 3360 BF5F4 CMP $03      ;if current device is screen
F5F6 F0F9 3361 BEQ BF5F1 ;indicate error
F5F8 905F 3362 BCC BF659 ;skip if cassette
F5FA A961 3363 LDA $61 ;device must be serial bus,
F5FC 85B9 3364 STA ZB9 ;set temporary sec. adr to Output
F5FE A4B7 3365 LDY ZB7 ;if file name is not present
F600 D003 3366 BNE BF605
F602 4C10F7 3367 JMP JF710 ;indicate File Name Missing
3368 ;
F605 20D5F3 3369 BF605 JSR SF3D5 ;perform open for serial bus device
F608 208FF6 3370 JSR SF68F ;print Saving + file name
F60B A5BA 3371 LDA ZBA ;get current device
F60D 200CED 3372 JSR SEDOC ;and send LISTEN on serial bus
F610 A5B9 3373 LDA ZB9 ;send secondary address
F612 20B9ED 3374 JSR SEBD9 ;on serial bus
F615 A000 3375 LDY $00
F617 208EFB 3376 JSR SFB8E ;move ptr to I/O area into ZAC/D
F61A A5AC 3377 LDA ZAC
F61C 20DDED 3378 JSR JEDDD ;send low of start address on serial bus
F61F A5AD 3379 LDA ZAD
F621 20DDED 3380 JSR JEDDD ;then high byte
F624 20D1FC 3381 BF624 JSR SFCD1 ;if block is not finished
F627 B016 3382 BCS BF63F
F629 B1AC 3383 LDA (ZAC),Y ;fetch next byte
F62B 20DDED 3384 JSR JEDDD ;and send on serial bus
F62E 20E1FF 3385 JSR SFEE1 ;check for Stop key
F631 D007 3386 BNE BF63A
F633 2042F6 3387 JF633 JSR SF642 ;and close serial bus if depressed
F636 A900 3388 LDA $00
F638 38   3389 SEC
F639 60   3390 RTS
3391 ;
F63A 20DBFC 3392 BF63A JSR SFCDB ;increment address
F63D D0E5 3393 BNE BF624 ;and repeat
F63F 20FEED 3394 BF63F JSR SEDFE ;send UNLISTEN on the serial bus

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            3396 ;close serial bus device
            3397 ;
F642 24B9  3398 SF642 BIT ZB9      ;if secondary address valid,
F644 3011  3399 BMI BF657
F646 A5BA  3400 LDA ZBA      ;get current device
F648 200CED 3401 JSR SEDOC      ;and send LISTEN on serial bus
F64B A5B9  3402 LDA ZB9      ;fetch secondary address
F64D 29EF  3403 AND $EF      ;strip bit 4
F64F 09EO  3404 ORA $EO      ;force bits 7-5
F651 20B9ED 3405 JSR SEDB9      ;send secondary addr after LISTEN
F654 20FEE0 3406 JF654 JSR SEDFE      ;send UNLISTEN on serial bus
F657 18    3407 BF657 CLC
F658 60    3408 RTS
            3409 ;
F659 4A    3410 BF659 LSR A      ;if device is not cassette
F65A B003  3411 BCS BF65F
F65C 4C13F7 3412 JMP JF713      ;indicate Illegal Device #
            3413 ;
            3414 ;save RAM to cassette
            3415 ;
F65F 20D0F7 3416 BF65F JSR SF7D0      ;set tape buffer pointer in XY
F662 908D  3417 BCC BF5F1      ;exit if address invalid
F664 2038F8 3418 JSR SF838      ;print msgs for cassette and test sense
F667 B025  3419 BCS BF68E
F669 208F6  3420 JSR SF68F      ;print message Saving + file name
F66C A203  3421 LDX $03
F66E A5B9  3422 LDA ZB9
F670 2901  3423 AND $01      ;if secondary address is even,
F672 D002  3424 BNE BF676
F674 A201  3425 LDX $01      ;set secondary address to 1
F676 8A    3426 BF676 TXA
F677 206AF7 3427 JSR SF76A      ;write Program Header block to cassette
F67A B012  3428 BCS BF68E      ;exit upon error
F67C 2067F8 3429 JSR SF867      ;write block to cassette
F67F B00D  3430 BCS BF68E      ;again, exit upon error
F681 A5B9  3431 LDA ZB9      ;if write End-Of-Tape Mark specified,
F683 2902  3432 AND $02
F685 F006  3433 BEQ BF68D
F687 A905  3434 LDA $05      ;then write special block
F689 206AF7 3435 JSR SF76A
F68C 24    3436 .BY $24      ;skip next instruction
F68D 18    3437 BF68D CLC      ;indicate no errors
F68E 60    3438 BF68E RTS
            3439 ;
            3440 ;handle message Saving plus file name
            3441 ;
F68F A59D  3442 SF68F LDA Z9D
F691 10FB  3443 BPL BF68E      ;return if not in Direct mode
F693 A051  3444 LDY $51      ;point to message SAVING
F695 202FF1 3445 JSR BF12F      ;print message
F698 4CC1F5 3446 JMP JF5C1      ;then print file name

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3448 ;increment real time clock
3449 ;
F69B A200 3450 JF69B LDX $00
F69D E6A2 3451 INC ZA2      ;bump low byte
F69F D006 3452 BNE BF6A7
F6A1 E6A1 3453 INC ZA1      ;then middle byte upon overflow
F6A3 D002 3454 BNE BF6A7
F6A5 E6A0 3455 INC ZAO      ;then high byte upon overflow
F6A7 38   3456 BF6A7 SEC
F6A8 A5A2 3457 LDA ZA2      ;check for full 24 hours
F6AA E901 3458 SBC $01
F6AC A5A1 3459 LDA ZA1
F6AE E91A 3460 SBC $1A
F6B0 A5A0 3461 LDA ZAO
F6B2 E94F 3462 SBC $4F
F6B4 9006 3463 BCC BF6BC
F6B6 86A0 3464 STX ZA0      ;yes, clear clock
F6B8 86A1 3465 STX ZA1
F6BA 86A2 3466 STX ZA2
F6BC AD01DC 3467 BF6BC LDA XDC01 ;read current keyboard scan line
F6BF CD01DC 3468 CMP XDC01
F6C2 D0F8 3469 BNE BF6BC ;wait until steady
F6C4 AA   3470 TAX
F6C5 3013 3471 BMI BF6DA
F6C7 A2BD 3472 LDX $BD      ;select Stop key row
F6C9 8E00DC 3473 STX XDC00
F6CC AE01DC 3474 BF6CC LDX XDC01 ;read column
F6CF EC01DC 3475 CPX XDC01
F6D2 D0F8 3476 BNE BF6CC ;wait until steady
F6D4 8D00DC 3477 STA XDC00
F6D7 E8   3478 INX
F6D8 D002 3479 BNE BF6DC
F6DA 8591 3480 BF6DA STA Z91 ;save scan result
F6DC 60   3481 BF6DC RTS
3482 ;
3483 ;read real time clock
3484 ;
F6DD 78   3485 JF6DD SEI      ;kill IRQ to avoid interference
F6DE A5A2 3486 LDA ZA2      ;read low byte into A
F6EO A6A1 3487 LDX ZA1      ;read middle byte into X
F6E2 A4A0 3488 LDY ZAO      ;and high byte into Y
3489 ;
3490 ;set real time clock
3491 ;
'JFS: €' 3492 JF6E4 SEI      ;disable IRQ to avoid interference
F6E5 85A2 3493 STA ZA2      ;set low byte from A
F6E7 86A1 3494 STX ZA1      ;set middle byte from X
F6E9 84A0 3495 STY ZAO      ;and set high byte from Y
F6EB 58   3496 CLI         ;enable IRQ's
F6EC 60   3497 RTS

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3499 ;test STOP key
3500 ;
F6ED A591 3501 WF6ED LDA Z91
F6EF C97F 3502 CMP $7F ;if Stop key is depressed
F6F1 D007 3503 BNE BF6FA
F6F3 08 3504 PHP ;save flags on stack
F6F4 20CCFF 3505 JSR SFFCC ;close files and set devices to default
F6F7 85C6 3506 STA ZC6 ;cancel keyboard queue
F6F9 28 3507 PLP ;restore flags
F6FA 60 3508 BF6FA RTS
3509 ;
3510 ;handle I/O errors
3511 ;
F6FB A901 3512 JF6FB LDA $01 ;Too Many Files
F6FD 2C 3513 .BY $2C
F6FE A902 3514 JF6FE LDA $02 ;File Open
F700 2C 3515 .BY $2C
F701 A903 3516 JF701 LDA $03 ;File Not Open
F703 2C 3517 .BY $2C
F704 A904 3518 JF704 LDA $04 ;File Not Found
F706 2C 3519 .BY $2C
F707 A905 3520 JF707 LDA $05 ;Device Not Present
F709 2C 3521 .BY $2C
F70A A906 3522 JF70A LDA $06 ;Not Input File
F70C 2C 3523 .BY $2C
F70D A907 3524 JF70D LDA $07 ;Not Output File
F70F 2C 3525 .BY $2C
F710 A908 3526 JF710 LDA $08 ;File Name Missing
F712 2C 3527 .BY $2C
F713 A909 3528 JF713 LDA $09 ;Illegal Device #
F715 48 3529 PHA ;save error # on stack
F716 20CCFF 3530 JSR SFFCC ;close files and set devices to default
F719 A000 3531 LDY $00
F71B 249D 3532 BIT Z9D
F71D 500A 3533 BVC BF729 ;if bit 6 in Direct/Run flag is set
F71F 202FF1 3534 JSR BF12F ;print message I/O Error
F722 68 3535 PLA
F723 48 3536 PHA
F724 0930 3537 ORA $30
F726 20D2FF 3538 JSR SFFD2 ;followed by error #
F729 68 3539 BF729 PLA ;restore error number
F72A 38 3540 SEC ;set error flag
F72B 60 3541 RTS

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3543 ;get next file header from cassette
3544 ;
F72C A593 3545 SF72C LDA Z93      ;save load/verify switch on stack
F72E 48    3546 PHA
F72F 2041F8 3547 JSR SF841      ;read a block from tape
F732 68    3548 PLA
F733 8593  3549 STA Z93      ;restore load/verify flag
F735 B032  3550 BCS BF769      ;exit if read error
F737 A000  3551 LDY $00
F739 B1B2  3552 LDA (ZB2),Y ;get first character in tape buffer
F73B C905  3553 CMP $05      ;if code for End of Tape
F73D F02A  3554 BEQ BF769      ;return
F73F C901  3555 CMP $01
F741 F008  3556 BEQ BF74B      ;if not code for Program Header
F743 C903  3557 CMP $03      ;or "?"
F745 F004  3558 BEQ BF74B
F747 C904  3559 CMP $04
F749 DOE1   3560 BNE SF72C      ;or Data Header, try next block
F74B AA    3561 BF74B TAX
F74C 249D  3562 BIT Z9D      ;if in direct mode,
F74E 1017  3563 BPL BF767
F750 A063  3564 LDY $63      ;point to message FOUND
F752 202FF1 3565 JSR BF12F      ;and print it
F755 A005  3566 LDY $05
F757 B1B2  3567 BF757 LDA (ZB2),Y
F759 20D2FF 3568 JSR SFFD2      ;print a file name character
F75C C8    3569 INY
F75D C015  3570 CPY $15      ;and repeat for
F75F D0F6  3571 BNE BF757      ;all 21 characters
F761 A5A1  3572 BF761 LDA ZA1
F763 20E0E4 3573 JSR SE4E0      ;display file name for max. 8.5 seconds
F766 EA    3574 NOP          ;filler for patch
F767 18    3575 BF767 CLC
F768 88    3576 DEY
F769 60    3577 BF769 RTS

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            3579 ;write a special block to cassette with code from A
            3580 ;
F76A 859E 3581 SF76A STA Z9E      ;save code from A
F76C 20D0F7 3582      JSR SF7D0    ;set tape buffer index in XY
F76F 905E 3583      BCC BF7CF   ;exit if address invalid
F771 A5C2 3584      LDA ZC2     ;save I/O start address on stack
F773 48 3585      PHA
F774 A5C1 3586      LDA ZC1
F776 48 3587      PHA
F777 A5AF 3588      LDA ZAF     ;save ptr to end of I/O area on stack
F779 48 3589      PHA
F77A A5AE 3590      LDA ZAE
F77C 48 3591      PHA
F77D A0BF 3592      LDY $BF
F77F A920 3593      LDA $20
F781 91B2 3594 BF781 STA (ZB2),Y ;clear cassette buffer with spaces
F783 88 3595      DEY
F784 D0FB 3596      BNE BF781
F786 A59E 3597      LDA Z9E      ;move routine entry code
F788 91B2 3598      STA (ZB2),Y ;into first byte of cassette buffer
F78A C8 3599      INY
F78B A5C1 3600      LDA ZC1     ;move pointer to I/O area
F78D 91B2 3601      STA (ZB2),Y ;+ 1
F78F C8 3602      INY
F790 A5C2 3603      LDA ZC2
F792 91B2 3604      STA (ZB2),Y ;and + 2
F794 C8 3605      INY
F795 A5AE 3606      LDA ZAE      ;move pointer to end of I/O area into
F797 91B2 3607      STA (ZB2),Y ;+ 3
F799 C8 3608      INY
F79A A5AF 3609      LDA ZAF
F79C 91B2 3610      STA (ZB2),Y ;and + 4
F79E C8 3611      INY
F79F 849F 3612      STY Z9F      ;save index into tape buffer
F7A1 A000 3613      LDY $00
F7A3 849E 3614      STY Z9E      ;initialize file name index
F7A5 A49E 3615 BF7A5 LDY Z9E
F7A7 C4B7 3616      CPY ZB7     ;if not at end of file name
F7A9 FOOC 3617      BEQ BF7B7
F7AB B1BB 3618      LDA (ZBB),Y ;move file name
F7AD A49F 3619      LDY Z9F
F7AF 91B2 3620      STA (ZB2),Y ;into tape buffer
F7B1 E69E 3621      INC Z9E     ;increment indexes
F7B3 E69F 3622      INC Z9F
F7B5 DOEE 3623      BNE BF7A5   ;and repeat
F7B7 20D7F7 3624 BF7B7 JSR SF7D7 ;set cassette buffer to I/O area
F7BA A969 3625      LDA $69
F7BC 85AB 3626      STA ZAB     ;set 105 sync patterns
F7BE 206BF8 3627      JSR SF86B ;write block to tape
F7C1 A8 3628      TAY
F7C2 68 3629      PLA
F7C3 85AE 3630      STA ZAE     ;restore ptr to beginning of I/O area
F7C5 68 3631      PLA
F7C6 85AF 3632      STA ZAF
F7C8 68 3633      PLA
F7C9 85C1 3634      STA ZC1     ;restore pointer to end of I/O area
F7CB 68 3635      PLA
F7CC 85C2 3636      STA ZC2
F7CE 98 3637      TYA
F7CF 60 3638 BF7CF RTS

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3640 ;set tape buffer pointer in XY
3641 ;
F7D0 A6B2 3642 SF7D0 LDX ZB2      ;move X to low part of tape buffer ptr
F7D2 A4B3 3643 LDY ZB3      ;and Y to high part
F7D4 C002 3644 CPY $02      ;set C if address invalid
F7D6 60   3645 RTS
3646 ;
3647 ;set cassette buffer to I/O area
3648 ;
F7D7 20D0F7 3649 SF7D7 JSR SF7D0      ;set tape buffer address in XY
F7DA 8A    3650 TXA
F7DB 85C1 3651 STA ZC1      ;move to I/O start address
F7DD 18    3652 CLC
F7DE 69C0 3653 ADC $C0      ;add 192
F7E0 85AE 3654 STA ZAE      ;to form low part of end of I/O area
F7E2 98    3655 TYA
F7E3 85C2 3656 STA ZC2      ;move high byte also
F7E5 6900 3657 ADC $00
F7E7 85AF 3658 STA ZAF
F7E9 60    3659 RTS
3660 ;
3661 ;search tape for a file name
3662 ;
F7EA 202CF7 3663 SF7EA JSR SF72C      ;read next file header from tape
F7ED B01D 3664 BCS BF80C      ;exit upon error
F7EF A005 3665 LDY $05
F7F1 849F 3666 STY Z9F      ;set temporary index in tape buffer
F7F3 A000 3667 LDY $00
F7F5 849E 3668 STY Z9E      ;set temporary index in file name
F7F7 C4B7 3669 BF7F7 CPY ZB7      ;if at end of file name
F7F9 F010 3670 BEQ BF80B      ;then name found
F7FB B1BB 3671 LDA (ZBB),Y      ;get character from file name
F7FD A49F 3672 LDY Z9F
F7FF D1B2 3673 CMP (ZB2),Y      ;and compare to tape buffer
F801 DOE7 3674 BNE SF7EA      ;if not equal, try next entry from tape
F803 E69E 3675 INC Z9E      ;else bump pointers
F805 E69F 3676 INC Z9F
F807 A49E 3677 LDY Z9E
F809 DOEC 3678 BNE BF7F7      ;and repeat test
F80B 18    3679 BF80B CLC      ;clear error flag
F80C 60    3680 BF80C RTS
3681 ;
3682 ;add 1 to tape index and test for overflow
3683 ;
F80D 20D0F7 3684 SF80D JSR SF7D0      ;get tape buffer pointer in XY
F810 E6A6 3685 INC ZA6      ;and add 1
F812 A4A6 3686 LDY ZA6
F814 COCO 3687 CPY $C0      ;set C if end of block
F816 60    3688 RTS

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3690 ;handle messages and test cassette buttons for read
3691 ;
F817 202EF8 3692 SF817 JSR SF82E      ;test sense line
F81A F01A 3693 BEQ BF836      ;if no buttons depressed,
F81C A01B 3694 LDY $1B      ;point to message Press Play on Tape
F81E 202FF1 3695 BF81E JSR BF12F      ;and print message
F821 20D0F8 3696 BF821 JSR SF8D0      ;test Stop key
F824 202EF8 3697 JSR SF82E      ;test sense line
F827 D0F8 3698 BNE BF821      ;and repeat if no buttons depressed
F829 A06A 3699 LDY $6A      ;point to message OK
F82B 4C2FF1 3700 JMP BF12F      ;and print
3701 ;
3702 ;test sense line for a button depressed on cassette
3703 ;
F82E A910 3704 SF82E LDA $10      ;set mask for sense line
F830 2401 3705 BIT Z01      ;test 6510 I/O register
F832 D002 3706 BNE BF836      ;exit with Z clear if nothing depressed
F834 2401 3707 BIT Z01      ;else set Z
F836 18   3708 BF836 CLC
F837 60   3709 RTS
3710 ;
3711 ;set messages and test cassette sense line for output
3712 ;
F838 202EF8 3713 SF838 JSR SF82E      ;test sense switches
F83B F0F9 3714 BEQ BF836      ;if no buttons depressed
F83D A02E 3715 LDY $2E      ;index message Press Next & Play...
F83F D0DD 3716 BNE BF81E      ;print message, test sense and return
3717 ;
3718 ;read a block from cassette
3719 ;
F841 A900 3720 SF841 LDA $00
F843 8590 3721 STA Z90      ;clear ST
F845 8593 3722 STA Z93      ;set load/verify switch to load
F847 20D7F7 3723 JSR SF7D7      ;set tape buffer to I/O area
F84A 2017F8 3724 SF84A JSR SF817      ;handle msgs and test sense for read
F84D B01F 3725 BCS BF86E
F84F 78   3726 SEI      ;disable IRQ
F850 A900 3727 LDA $00
F852 85AA 3728 STA ZAA      ;set gap
F854 85B4 3729 STA ZB4      ;set no sync established
F856 85B0 3730 STA ZB0      ;set no special speed correction yet
F858 859E 3731 STA Z9E      ;initialize error log index for pass 1
F85A 859F 3732 STA Z9F      ;and pass 2
F85C 859C 3733 STA Z9C      ;set no byte available yet
F85E A990 3734 LDA $90      ;set Flag mask
F860 A20E 3735 LDX $0E      ;index for cassette read IRQ address
F862 D011 3736 BNE BF875      ;JMP

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3738 ;write a block to cassette
3739 ;
F864 20D7F7 3740 SF864 JSR SF7D7      ;initialize tape buffer pointer
F867 A914 3741 SF867 LDA $14
F869 85AB 3742 STA ZAB      ;20 sync patterns
F86B 2038F8 3743 SF86B JSR SF838      ;test sense and display msgs for output
F86E B06C 3744 BF86E BCS BF8DC
F870 78 3745 SEI
F871 A982 3746 LDA $82      ;mask for ICRL to honor TBL
F873 A208 3747 LDX $08      ;IRQ index for cassette write, part 1
3748 ;
3749 ;common code for cassette read & write
3750 ;
F875 A07F 3751 BF875 LDY $7F
F877 8CODDC 3752 STY XDCOD      ;clear any pending masks in ICRL
F87A 8DODDC 3753 STA XDCOD      ;then set mask for TBL
F87D ADOEDC 3754 LDA XDCOE
F880 0919 3755 ORA $19      ;+ force load, one shot and TBL to CRA1
F882 8DOFDC 3756 STA XDCOF      ;to form CRB1
F885 2991 3757 AND $91
F887 8DA202 3758 STA X02A2      ;and CRB1 activity register
F88A 20A4F0 3759 JSR SFOA4      ;condition flag bit in ICR2
F88D AD11D0 3760 LDA X0D11
F890 29EF 3761 AND $EF
F892 8D11D0 3762 STA X0D11      ;disable the screen
F895 AD1403 3763 LDA X0314      ;save standard IRQ vector
F898 8D9F02 3764 STA X029F
F899 AD1503 3765 LDA X0315
F89E 8DA002 3766 STA X02AO
F8A1 20BDFC 3767 JSR SFCBD      ;set new IRQ for cassette depending on X
F8A4 A902 3768 LDA $02
F8A6 85BE 3769 STA ZBE      ;select phase 2
F8A8 2097FB 3770 JSR SFB97      ;initialize cassette I/O variables
F8AB A501 3771 LDA Z01
F8AD 291F 3772 AND $1F
F8AF 8501 3773 STA Z01      ;start cassette motor
F8B1 85C0 3774 STA ZCO      ;set tape motor interlock
F8B3 A2FF 3775 LDX $FF
F8B5 AOFF 3776 BF8B5 LDY $FF
F8B7 88 3777 BF8B7 DEY      ;delay .3 seconds
F8B8 DOFD 3778 BNE BF8B7
F8BA CA 3779 DEX
F8BB DOF8 3780 BNE BF8B5
F8BD 58 3781 CLI
F8BE ADA002 3782 JF8BE LDA X02AO      ;test high byte of IRQ save area
F8C1 CD1503 3783 CMP X0315      ;to determine if end of I/O
F8C4 18 3784 CLC
F8C5 F015 3785 BEQ BF8DC      ;exit if so
F8C7 20D0F8 3786 JSR SF8D0      ;else test Stop key
F8CA 20BCF6 3787 JSR BF6BC      ;scan keyboard
F8CD 4CBEB8 3788 JMP JF8BE      ;repeat

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            3790 handle Stop key during cassette operations
            3791 ;
F8D0 20E1FF 3792 SF8D0 JSR SFFE1      ;test Stop key
F8D3 18     3793     CLC
F8D4 D00B   3794     BNE BF8E1
F8D6 2093FC 3795     JSR SFC93      ;if depressed, stop cassette operations
F8D9 38     3796     SEC
F8DA 68     3797     PLA      ;delete own return address
F8DB 68     3798     PLA
F8DC A900   3799 BF8DC LDA $00
F8DE 8DA002 3800 STA X02A0      ;clear high byte of IRQ save area
F8E1 60     3801 BF8E1 RTS
            3802 ;
            3803 ;schedule CIA1 Timer A depending in parameter in X
            3804 ;
F8E2 66B1   3805 SF8E2 STX ZB1      ;save entry parameter
F8E4 A5E0   3806 LDA ZB0      ;get speed correction
F8E6 0A     3807 ASL A      ;* 2
F8E7 0A     3808 ASL A      ;* 4
F8E8 18     3809 CLC
F8E9 65B0   3810 ADC ZE0      ;add speed correction
F8EB 18     3811 CLC
F8EC 65B1   3812 ADC ZB1      ;and parameter
F8EE 85P1   3813 STA ZB1      ;save low order
F8FO A900   3814 LDA $00
F8F2 24B0   3815 BIT ZB0      ;if speed correction is positive
F8F4 3001   3816 BMI BF8F7
F8F6 2A     3817 ROL A      ;get high order in A
F8F7 06B1   3818 BF8F7 ASL ZB1
F8F9 2A     3819 ROL A      ;* 2
F8FA 06B1   3820 ASL ZB1
F8FC 2A     3821 ROL A      ;* 4
F8FD AA     3822 TAX
F8FE AD06DC 3823 BF8FE LDA XDC06      ;wait until no chance of
F901 C916   3824 CMP $16      ;TBL1 changing
F903 90F9   3825 BCC BF8FE      ;while it still must be read
F905 65B1   3826 ADC ZB1      ;add low order offset to TBL1
F907 8D04DC 3827 STA XDC04      ;and store in TBL1
F90A 8A     3828 TXA
F90B 6D07DC 3829 ADC XDC07      ;add high order offset to TBH1
F90E 8D05DC 3830 STA XDC05      ;and store in TAHI
F911 ADA202 3831 LDA X02A2
F914 8D0EDC 3832 STA XDC0E      ;set CRAL from CRB1 activity register
F917 3DA402 3833 STA X02A4      ;and save it
F91A ADODDC 3834 LDA XDC0D
F91D 2910   3835 AND $10
F91F F009   3836 BEQ BF92A      ;if Flag bit is not set,
F921 A9F9   3837 LDA >BF92A      ;set exit address on stack
F923 48     3838 PEA
F924 A92A   3839 LDA <BF92A
F926 48     3840 PHA
F927 4C43FF 3841 JMP JFF43      ;and simulate an IRQ
F92A 58     3842 BF92A CLI      ;else allow IRQ and exit
F92B 60     3843 RTS

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3845 ;cassette read IRQ routine
3846 ;
F92C 3847 WF92C = *
F92C AE07DC 3848 BF92C LDX XDC07 ;get TBH1
F92F A0FF 3849 LDY $FF
F931 98 3850 TYA ;and complement of TBL1
F932 ED06DC 3851 SBC XDC06 ;(time elapsed)
F935 EC07DC 3852 CPX XDC07 ;if high byte not steady,
F938 D0F2 3853 BNE BF92C ;repeat
F93A 86B1 3854 STX ZB1 ;else save high byte
F93C AA 3855 TAX
F93D 8C06DC 3856 STY XDC06 ;reset TBL1 to maximum
F940 8C07DC 3857 STY XDC07 ;ditto TBH1
F943 A919 3858 LDA $19 ;force load, one-shot and Timer B
F945 8DOFDC 3859 STA XDC0F ;into CRB1
F948 AD0DDC 3860 LDA XDC0D
F94B 8DA302 3861 STA X02A3 ;save ICR1
F94E 98 3862 TYA
F94F E5B1 3863 SBC ZB1 ;complement high byte
F951 86B1 3864 STX ZB1 ;save low byte
F953 4A 3865 LSR A ;elapsed time in A, ZB1
F954 66B1 3866 ROR ZB1 ;/ 2
F956 4A 3867 LSR A ;/ 4
F957 66B1 3868 ROR ZB1 ;get speed correction
F959 A5B0 3869 LDA ZB0
F95B 18 3870 CLC
F95C 693C 3871 ADC $3C ;+ 240 microseconds
F95E C5B1 3872 CMP ZB1 ;if cycle shorter
F960 B04A 3873 BCS BF9AC ;dismiss
F962 A69C 3874 LDX Z9C ;if byte available
F964 F003 3875 BEQ BF969
F966 4C60FA 3876 JMP JFA60 ;receive it
            3877 ;
F969 A6A3 3878 BF969 LDX ZA3 ;test bit count and if beyond last bit,
F96B 301B 3879 BMI BF988 ;do end of byte
F96D A200 3880 LDX $00 ;assume bit value of 0
F96F 6930 3881 ADC $30 ;add 432 microseconds
F971 65B0 3882 ADC ZB0 ;+ 2 * speed correction
F973 C5B1 3883 CMP ZB1 ;if cycle shorter
F975 B01C 3884 BCS BF993 ;record a 0
F977 E8 3885 INX ;assume bit value of 1
F978 6926 3886 ADC $26 ;get 584 microseconds
F97A 65B0 3887 ADC ZB0 ;+ 3 * speed correction
F97C C5B1 3888 CMP ZB1 ;if cycle shorter
F97E B017 3889 BCS BF997 ;record a 1
F980 692C 3890 ADC $2C ;get 760 microseconds
F982 65B0 3891 ADC ZB0 ;+ 4 * speed correction
F984 C5B1 3892 CMP ZB1 ;if cycle shorter
F986 9003 3893 BCC BF98B
F988 4C10FA 3894 BF988 JMP JFA10 ;go do end of byte
            3895 ;
F98B A5B4 3896 BF98B LDA ZB4 ;if sync established
F98D F01D 3897 BEQ BF9AC
F98F 85A8 3898 STA ZA8 ;set erroneous bits
F991 D019 3899 BNE BF9AC ;for a 0, increment 0/1 balance
F993 E6A9 3900 BF993 INC ZA9
F995 B002 3901 BCS BF999 ;for a 1, decrement 0/1 balance
F997 C6A9 3902 BF997 DEC ZA9
F999 38 3903 BF999 SEC ;0/1 cutoff level
F99A E913 3904 SBC $13

```

F99C E5B1	3905	SBC ZB1	; - cycle width
F99E 6592	3906	ADC Z92	
F9A0 8592	3907	STA Z92	; accumulated for speed correction
F9A2 A5A4	3908	LDA ZA4	
F9A4 4901	3909	EOR \$01	; flip cycle indication
F9A6 85A4	3910	STA ZA4	
F9A8 F02B	3911	BEQ BF9D5	; if first cycle,
F9AA 86D7	3912	STX ZD7	; save bit value
F9AC A5B4	3913	BF9AC LDA ZB4	; if no sync yet
F9AE F022	3914	BEQ BF9D2	; return from IRQ
F9B0 ADA302	3915	LDA X02A3	; if ICRL mask
F9B3 2901	3916	AND \$01	
F9B5 D005	3917	BNE BF9BC	
F9B7 ADA402	3918	LDA X02A4	; and last CRA1 mask shows no TAI flag,
F9BA D016	3919	BNE BF9D2	; exit from IRQ
F9BC A900	3920	BF9BC LDA \$00	
F9BE 85A4	3921	STA ZA4	; clear cycle count
F9C0 8DA402	3922	STA X02A4	; and last CRA1 mask
F9C3 A5A3	3923	LDA ZA3	; if bit count indicates end of byte,
F9C5 1030	3924	BPL BF9F7	
F9C7 30BF	3925	BMI BF988	; go do end of byte
F9C9 A2A6	3926	BF9C9 LDX \$A6	
F9CB 20E2F8	3927	JSR SF8E2	; schedule timer
F9CE A59B	3928	LDA Z9B	; if parity calculated does not match
F9D0 D0B9	3929	BNE BF98B	; set erroneous bit flag
F9D2 4CBCFE	3930	BF9D2 JMP JFEBC	; exit from IRQ
	3931 ;		
F9D5 A592	3932	BF9D5 LDA Z92	; if second cycle,
F9D7 F007	3933	BEQ BF9E0	; check accumulated over/under time
F9D9 3003	3934	BMI BF9DE	
F9DB C6B0	3935	DEC ZB0	
F9DD 2C	3936	.BY \$2C	; skip next instruction
F9DE E6B0	3937	BF9DE INC ZB0	; adapt speed correction accordingly
F9EO A900	3938	BF9E0 LDA \$00	
F9E2 8592	3939	STA Z92	; reset accumulated over/under time
F9E4 E4D7	3940	CPX ZD7	; if 2nd cycle = complement of cycle 1,
F9E6 D00F	3941	BNE BF9F7	; include bit
F9E8 8A	3942	TXA	
F9E9 D0A0	3943	BNE BF98B	; if two 0 cycles
F9EB A5A9	3944	LDA ZA9	; and 0/1 balance
F9ED 30BD	3945	BMI BF9AC	
F9EF C910	3946	CMP \$10	; at least 16 "0" cycles extra
F9F1 90B9	3947	BCC BF9AC	
F9F3 8596	3948	STA Z96	
F9F5 B0B5	3949	BCS BF9AC	
F9F7 8A	3950	BF9F7 TXA	
F9F8 459B	3951	EOR Z9B	; calculate parity
F9FA 85B9	3952	STA Z9B	
F9FC A5B4	3953	LDA ZB4	; if no sync yet,
F9FE F0D2	3954	BEQ BF9D2	; exit
FA00 C6A3	3955	DEC ZA3	; decrement pending bit count
FA02 30C5	3956	BMI BF9C9	; after last bit, check parity
FA04 46D7	3957	LSR ZD7	; include bit
FA06 66BF	3958	ROR ZBF	; in byte being read
FA08 A2DA	3959	LDX \$DA	
FA0A 20E2F8	3960	JSR SF8E2	; schedule timer
FA0D 4CBCFE	3961	JMP JFEBC	; exit from IRQ
	3962 ;		
FA10 A596	3963	JFA10 LDA Z96	; if sync detected
FA12 F004	3964	BEQ BFA18	

FA14 A5P4	3965	LDA ZB4	;and not yet established
FA16 F007	3966	BEQ BFA1F	
FA18 A5A3	3967	BFA18 LDA ZA3	;or last bit done
FA1A 3003	3968	BMI BFA1F	
FA1C 4C97F9	3969	JMP BF997	;allow byte reception
	3970 ;		
FA1F 46B1	3971	BFA1F LSR ZB1	;compute new speed correction value
FA21 A993	3972	LDA \$93	
FA23 38	3973	SEC	
FA24 E5B1	3974	SBC ZB1	
FA26 65B0	3975	ADC ZB0	
FA28 0A	3976	ASL A	
FA29 AA	3977	TAX	
FA2A 20E2F8	3978	JSR SF6E2	;schedule timer
FA2D E69C	3979	INC Z9C	;indicate byte available
FA2F A5B4	3980	LDA ZB4	;if no sync established yet,
FA31 D011	3981	BNE BFA44	
FA33 A596	3982	LDA Z96	;but sync detected
FA35 F026	3983	BEQ BFA5D	
FA37 85A8	3984	STA ZA8	;set error bits
FA39 A900	3985	LDA \$00	
FA3B 8596	3986	STA Z96	;clear sync detected
FA3D A981	3987	LDA \$81	;set TA1 bit
FA3F 8DODDC	3988	STA XDCOD	;in ICRL
FA42 85B4	3989	STA ZB4	;set sync established
FA44 A596	3990	BFA44 LDA Z96	;move sync status
FA46 85B5	3991	STA ZB5	;to saved sync status
FA48 F009	3992	BEQ BFA53	
FA4A A900	3993	LDA \$00	;if not detected,
FA4C 85B4	3994	STA ZB4	;indicate sync not established
FA4E A901	3995	LDA \$01	
FA50 8DODDC	3996	STA XDCOD	;clear TA mask in ICRL
FA53 A5BF	3997	BFA53 LDA ZBF	;save byte read
FA55 85BD	3998	STA ZBD	
FA57 A5A8	3999	LDA ZA8	
FA59 05A9	4000	ORA ZA9	;accumulate possible errors
FA5B 85B6	4001	STA ZB6	
FA5D 4CBCFE	4002	BFA5D JMP JFEBC	;exit from IRQ

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        4004 ;receive next byte from cassette
        4005 ;
FA60 2097FB 4006 JFA60 JSR SF897 ;initialize cassette I/O variables
FA63 859C 4007 STA Z9C ;indicate no byte available yet
FA65 A2DA 4008 LDX $DA
FA67 20E2F8 4009 JSR SF8E2 ;schedule Timer
FA6A A5BE 4010 LDA ZBE ;if first or second phase being read,
FA6C F002 4011 BEQ BFA70
FA6E 85A7 4012 STA ZA7 ;copy into actual phase
FA70 A90F 4013 BFA70 LDA $0F
FA72 24AA 4014 BIT ZAA ;if data beyond area
FA74 1017 4015 BPL BFA8D
FA76 A5B5 4016 LDA ZB5 ;and in second half
FA78 D00C 4017 BNE BFA86
FA7A A6BE 401B LDX ZBE
FA7C CA 4019 DEX
FA7D D00B 4020 BNE BFABA
FA7F A908 4021 LDA $08 ;indicate Long Block in ST
FA81 201CFE 4022 JSR SFE1C
FA84 D004 4023 BNE BFA8A ;and exit
FA86 A900 4024 BFA86 LDA $00
FA88 85AA 4025 STA ZAA ;set gap
FA8A 4CBCFE 4026 BFA8A JMP JFEBC ;exit from IRQ
        4027 ;
FA8D 7031 402B BFA8D BVS BFAC0 ;if data, go collect
FA8F D01B 4029 BNE BFAA9 ;if header, decrement count
FA91 A5B5 4030 LDA ZB5 ;if gap and byte valid
FA93 D0F5 4031 BNE BFA8A
FA95 A5B6 4032 LDA ZB6 ;and no erroneous bits
FA97 D0F1 4033 BNE BFA8A
FA99 A5A7 4034 LDA ZA7 ;get actual phase
FA9B 4A 4035 LSR A ;bit 7 of byte
FA9C A5BD 4036 LDA ZBD
FA9E 3003 4037 BMI BFAA3
FAAO 9018 4038 BCC BFABA
FAA2 18 4039 CLC
FAA3 B015 4040 BFAA3 BCS BFABA ;must correspond to header phase
FAA5 290F 4041 AND $0F
FAA7 85AA 4042 STA ZAA ;set header count
FAA9 C6AA 4043 BFAA9 DEC ZAA ;decrement header count
FAAB D0DD 4044 BNE BFABA ;at end of header,
FAAD A940 4045 LDA $40
FAAF 85AA 4046 STA ZAA ;set data
FAB1 208EFB 4047 JSR SFBBE ;move beginning of I/O area into ZAC/D
FAB4 A900 4048 LDA $00
FAB6 85AB 4049 STA ZAB ;clear checksum
FAB8 FODO 4050 BEQ BFA8A
FABA A980 4051 BFABA LDA $80 ;if illegal header
FABC 85AA 4052 STA ZAA ;set Data After Area
FABE DOCA 4053 BNE BFA8A
FAC0 A5B5 4054 BFAC0 LDA ZB5 ;if data, but data not valid
FAC2 F00A 4055 BEQ BFACE
FAC4 A904 4056 LDA $04 ;set Short Block Error
FAC6 201CFE 4057 JSR SFE1C ;and indicate in ST
FAC9 A900 4058 LDA $00
FACB 4C4AFB 4059 JMP JFB4A ;do end of block
        4060 ;
FACE 20D1FC 4061 BFACE JSR SFCD1 ;if at end of area,
FAD1 9003 4062 BCC BFAD6
FAD3 4C48FB 4063 JMP JFB48 ;set data after area

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        4064 ;
FAD6 A6A7 4065 BFAD6 LDX ZA7      ;if actual phase = 1
FAD8 CA    4066 DEX
FAD9 F02D  4067 BEQ BFB08      ;do error correction
FADB A593  406B LDA Z93
FADD F00C  4069 BEQ BFAEB      ;if Verify pass
FADF A000  4070 LDY $00
FAE1 A5BD  4071 LDA ZBD
FAE3 D1AC  4072 CMP (ZAC),Y ;compare byte to current character
FAE5 F004  4073 BEQ BFAEB
FAE7 A901  4074 LDA $01
FAE9 8586  4075 STA ZB6      ;set error flag upon mismatch
FAEB A5B6  4076 BFAEB LDA ZB6      ;if errors
FAED F04B  4077 BEQ BFB3A
FAEF A23D  4078 LDX $3D
FAF1 E49E  4079 CPX Z9E      ;and error log table is not at maximum
FAF3 903E  4080 BCC BFB33
FAF5 A69E  40B1 LDX Z9E
FAF7 A5AD  4082 LDA ZAD
FAF9 9D0101 4083 STA X0100+1,X ;store pointer into error log table
FAFC A5AC  4084 LDA ZAC
FAFE 9D0001 40B5 STA X0100,X
FB01 EB    40B6 INX
FB02 E8    40B7 INX
FB03 B69E  40B8 STX Z9E      ;set new error log index
FB05 4C3AFB 4089 JMP BFB3A
        4090 ;
FB08 A69F  4091 BFB08 LDX Z9F
FB0A E49E  4092 CPX Z9E      ;if pass 2 error log index at maximum,
FB0C F035  4093 BEQ BFB43      ;no correction possible
FB0E A5AC  4094 LDA ZAC      ;else
FB10 DD0001 4095 CMP X0100,X ;check for match in error log table
FB13 D02E  4096 BNE BFB43
FB15 A5AD  4097 LDA ZAD
FB17 DD0101 4098 CMP X0100+1,X
FB1A D027  4099 BNE BFB43
FB1C E69F  4100 INC Z9F      ;if so, bump pass 2 error log index
FB1E E69F  4101 INC Z9F
FB20 A593  4102 LDA Z93      ;if Verify pass
FB22 F00B  4103 BEQ BFB2F
FB24 A5ED  4104 LDA ZBD
FB26 A000  4105 LDY $00
FB28 D1AC  4106 CMP (ZAC),Y ;compare byte to current character
FB2A F017  4107 BEQ BFB43      ;set error if not equal
FB2C C8    4108INY
FB2D 84B6  4109 STY ZB6
FB2F A5B6  4110 BFB2F LDA ZB6      ;if still an error
FB31 F007  4111 BEQ BFB3A
FB33 A910  4112 BFB33 LDA $10
FB35 201CFE 4113 JSR SFE1C      ;set Unrecoverable Read Error in ST
FB3B D009  4114 BNE BFB43
FB3A A593  4115 BFB3A LDA Z93      ;if Load,
FB3C D005  4116 BNE BFB43
FB3E A8    4117 TAY
FB3F A5BD  411B LDA ZBD
FB41 91AC  4119 STA (ZAC),Y ;store byte
FB43 20LBC 4120 BFB43 JSR SFCD8      ;increment address
FB46 D043  4121 BNE BFB8B      ;and exit
FB48 A980  4122 JFB48 LDA $80
FB4A 85AA  4123 JFB4A STA ZAA

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FB4C 78      4124    SEI
FB4D A201    4125    LDX $01
FB4F 8E0DDC  4126    STX XDCOD ;clear TA mask from ICR1
FB52 AE0DDC  4127    LDX XDCOD
FB55 A6BE    4128    LDX ZBE   ;if phase 1 or 2
FB57 CA      4129    DEX
FB58 3002    4130    BMI BFB5C
FB5A 86BE    4131    STX ZBE   ;decrement phase
FB5C C6A7    4132 BFB5C DEC ZA7 ;decrement actual phase
FB5E F008    4133    BEQ BFB68 ;if not end of block
FB60 A59E    4134    LDA Z9E   ;and no errors encountered
FB62 D027    4135    BNE BFB8B ;skip phase
FB64 85BE    4136    STA ZBE
FB66 F023    4137    BEQ BFB8B ;if end of block,
FB68 2093FC  4138 BFB68 JSR SFC93 ;switch from cassette to default IRQ
FB6B 208EFB  4139    JSR SFB8E ;move beginning of I/O area into ZAC/D
FB6E A000    4140    LDY $00
FB70 84AB    4141    STY ZAB   ;clear checksum value
FB72 B1AC    4142 BFB72 LDA (ZAC),Y ;compute checksum
FB74 45AB    4143    EOR ZAB
FB76 85AB    4144    STA ZAB
FB78 20DBFC  4145    JSR SFCDB ;bump address
FB7B 20D1FC  4146    JSR SFCD1 ;check for end of block
FB7E 90F2    4147    BCC BFB72
FB80 A5AB    4148    LDA ZAB
FB82 45BD    4149    EOR ZBD   ;if computed checksum does not match,
FB84 F005    4150    BEQ BFB8B
FB86 A920    4151    LDA $20
FB88 201CFE  4152    JSR SFE1C ;set Checksum Error in ST
FB8B 4CBCFE  4153 BFB8B JMP JFEBC ;return from IRQ

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4155 ;move save/load address into ZAC/D
4156 ;
FB8E A5C2 4157 SFB8E LDA ZC2      ;move high byte of save/load pointer
FB90 85AD 4158 STA ZAD
FB92 A5C1 4159 LDA ZC1      ;then low byte
FB94 85AC 4160 STA ZAC
FB96 60   4161 RTS
4162 ;
4163 ;initialize cassette read/write variables
4164 ;
FB97 A908 4165 SFB97 LDA $08
FB99 85A3 4166 STA ZA3      ;set bit count
FB9B A900 4167 LDA $00
FB9D 85A4 4168 STA ZA4      ;clear cycle count
FB9F 85A8 4169 STA ZA8      ;clear byte start cycle 1
FBA1 859B 4170 STA Z9B      ;clear parity bit
FBA3 85A9 4171 STA ZA9      ;clear byte start cycle 2
FBA5 60   4172 RTS
4173 ;
4174 ;schedule ICRL Timer B and invert cassette write line
4175 ;
FBA6 A5BD 4176 SFBA6 LDA ZBD
FBA8 4A   4177 LSR A      ;move bit 0 of current character into C
FBA9 A960 4178 LDA $60      ;start with value for a 0
FBAB 9002 4179 BCC BFBAF
FBAD A9B0 4180 SFBAD LDA $B0      ;if a 1 to be sent, set value for a 1
FBAB A200 4181 BFBAF LDX $00
FBB1 8D06DC 4182 SFBB1 STA XDC06      ;TBL1 set to 0
FBB4 8E07DC 4183 STX XDC07      ;TBH1 set to $60/$B0
FBB7 ADODDC 4184 LDA XDC0D
FBBB A919 4185 LDA $19      ;force load, one-shot and Timer B
FBBC 8D0FDC 4186 STA XDC0F      ;into CRB1
FBBF A501 4187 LDA Z01
FBC1 4908 4188 EOR $08      ;invert polarity of cassette write bit
FBC3 8501 4189 STA Z01
FBC5 2908 4190 AND $08      ;indicate polarity in A and Z
FBC7 60   4191 RTS

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4193 ;IRQ routine for cassette write, part 2 (at FBCD)
4194 ;
4195 ;used for byte start cycle and each half cycle per data bit
4196 ;
FBC8 38 4197 BFBC8 SEC
FBC9 66B6 4198 ROR ZB6 ;set current byte pointer => 32K
FBCB 303C 4199 BMI BFC09 ;JMP
FBCD A5A8 4200 WFBDC LDA ZA8 ;if byte start cycle 1
FBCF D012 4201 BNE BFBE3
FBDF A910 4202 LDA $10
FBD3 A201 4203 LDX $01 ;set AX to 272
FBD5 20B1FB 4204 JSR SFBB1 ;invert output and schedule timer
FBD8 D02F 4205 BNE BFC09 ;if output is zero again
FBDA E6A8 4206 INC ZA8 ;indicate cycle 1 finished
FBDC A5B6 4207 LDA ZB6 ;if current byte pointer => 32K
FBDE 1029 4208 BPL BFC09
FBE0 4C57FC 4209 JMP JFC57 ;switch to other cassette write IRQ
4210 ;
FBE3 A5A9 4211 BFBE3 LDA ZA9 ;if byte start cycle 2
FBE5 D009 4212 BNE BFBF0
FBE7 20ADFB 4213 JSR SFBAD ;invert output and schedule timer
FBEA D01D 4214 BNE BFC09 ;if output is zero again
FBECE6A9 4215 INC ZA9 ;increment count for 2 cycles per bit
FBEED019 4216 BNE BFC09
FBFO 20A6FB 4217 BFBFO JSR SFBAD ;invert output and schedule timer
FBF3 D014 4218 BNE BFC09 ;if output is zero again
FBF5 A5A4 4219 LDA ZA4
FBF7 4901 4220 EOR $01 ;increment count for 2 cycles per bit
FBF9 85A4 4221 STA ZA4
FBFB FOOF 4222 BEQ BFCOC ;if cycle is complete
FBFD A5BD 4223 LDA ZBD
FBFF 4901 4224 EOR $01 ;invert data bit for next cycle
FC01 85BD 4225 STA ZBD
FC03 2901 4226 AND $01 ;add bit
FC05 459B 4227 EOR Z9B ;to parity
FC07 8598 4228 STA Z9B
FC09 4CBCFE 4229 BFC09 JMP JFEBC ;and exit IRQ
4230 ;
FC0C 46BD 4231 BFCOC LSR ZBD ;if 2 cycles done,
FC0E C6A3 4232 DEC ZA3 ;decrement bit count
FC10 A5A3 4233 LDA ZA3
FC12 F03A 4234 BEQ BFC4E ;after byte, send parity bit
FC14 10F3 4235 BPL BFC09 ;during byte, send next bit
FC16 2097FB 4236 BFC16 JSR SFB97 ;at end of byte, reset variables
FC19 58 4237 CLI ;allow IRQ
FC1A A5A5 4238 LDA ZA5 ;if block header count
FC1C F012 4239 BEQ BFC30 ;not zero
FC1E A200 4240 LDX $00
FC20 86D7 4241 STX ZD7 ;clear checksum
FC22 C6A5 4242 DEC ZA5 ;decrement header count
FC24 A6BE 4243 LDX ZBE
FC26 E002 4244 CPX $02 ;if phase 2
FC28 D002 4245 BNE BFC2C
FC2A 0980 4246 ORA $80 ;add 128 to count
FC2C 85BD 4247 BFC2C STA ZBD ;and send count as data for header
FC2E D0D9 4248 BNE BFC09 ;return from IRQ
FC30 20D1FC 4249 BFC30 JSR SFCD1 ;if end of data reached
FC33 900A 4250 BCC BFC3F ;do next byte
FC35 D091 4251 BNE BFBC8 ;if beyond, waste time
FC37 E6AD 4252 INC ZAD ;if at end, set pointer beyond end

```

FC39 A5D7	4253	LDA ZD7	;get checksum
FC3B 85BD	4254	STA ZBD	;and send it
FC3D BOCA	4255	BCS BFC09	;return from IRQ
FC3F A000	4256	BFC3F LDY \$00	
FC41 B1AC	4257	LDA (ZAC),Y	;get next byte to write
FC43 85BD	4258	STA ZBD	;and move to output character buffer
FC45 45D7	4259	EOR ZD7	;compute checksum
FC47 85D7	4260	STA ZD7	
FC49 20DBFC	4261	JSR SFcdb	;advance address
FC4C D0BB	4262	BNE BFC09	;return from IRQ
FC4E A59B	4263	BFC4E LDA Z9B	;get parity bit
FC50 4901	4264	EOR \$01	;invert it
FC52 85BD	4265	STA ZBD	;put into output buffer
FC54 4C8CFE	4266	BFC54 JNP JFEBC	;return from IRQ
	4267 ;		
FC57 C6BE	4268	JFC57 DEC ZBE	;decrement phase
FC59 D003	4269	BNE BFC5E	;if phase is 0
FC5B 20CAF0	4270	JSR SFCCA	;stop cassette operations
FC5E A950	4271	BFC5E LDA \$50	;set # cycles per sync to 40
FC60 85A7	4272	STA ZA7	
FC62 A208	4273	LDX \$08	
FC64 78	4274	SEI	;set IRQ vector
FC65 20BDFA	4275	JSR SFCBD	;for cassette write, part 1
FC68 D0EA	4276	BNE BFC54	;return from IRQ

```

4278 ;IRQ routine for cassette write, part 1
4279 ;
4280 ;entered for each block copy and for end of block
4281 ;
FC6A A978 4282 WFC6A LDA $78
FC6C 20AFFB 4283 JSR BFBAF ;invert output and schedule Timer
FC6F DOE3 4284 BNE BFC54 ;if output is zero again
FC71 C6A7 4285 DEC ZA7 ;decrement cycle count per sync
FC73 D0DF 4286 BNE BFC54 ;when zero,
FC75 2097FB 4287 JSR SFB97 ;reset cassette read/write variables
FC78 C6AB 4288 DEC ZAB ;decrement sync count per block
FC7A 10D8 4289 BPL BFC54 ;if negative,
FC7C A20A 4290 LDX $0A ;set IRQ vector
FC7E 20BDFC 4291 JSR SFCBD ;to other cassette write routine
FC81 58 4292 CLI ;enable IRQ
FC82 E6AB 4293 INC ZAB ;sync count set to 0
FC84 A5BE 4294 LDA ZBE ;if phase = 0
FC86 F030 4295 BEQ BFCB8 ;go terminate
FC88 208EFB 4296 JSR SFB8E ;move start of I/O area to current addr
FC8B A209 4297 LDX $09
FC8D 86A5 4298 STX ZA5 ;set block header count
FC8F 86B6 4299 STX ZB6 ;and current byte pointer
FC91 D083 4300 BNE BFC16 ;go write block
4301 ;
4302 ;switch from cassette IRQ to default IRQ
4303 ;
FC93 08 4304 SFC93 PHP ;save flags
FC94 78 4305 SEI ;disable IRQ
FC95 AD11D0 4306 LDA XDO11
FC98 0910 4307 ORA $10 ;make screen visible again
FC9A 8D11D0 4308 STA XDO11
FC9D 20CAF0 4309 JSR SFCCA ;stop cassette motor
FCA0 A97F 4310 LDA $7F
FCA2 8D0DDC 4311 STA XDC0D ;clear mask for all IRQ's in ICRL
FCA5 20DDFD 4312 JSR SFDDD ;reset TA1 to 1/60 of a second
FCA8 ADA002 4313 LDA X02A0
FCAB F009 4314 BEQ BFCB6
FCAD 8D1503 4315 STA X0315 ;restore standard IRQ vector
FCB0 AD9F02 4316 LDA X029F
FCB3 8D1403 4317 STA X0314
FCB6 28 4318 BFCB6 PLP ;restore flags
FCB7 60 4319 RTS

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        4321 ;terminate cassette I/O
        4322 ;
FCCB8 2093FC 4323 BFCB8 JSR SFC93      ;switch from cassette to default IRQ
FCBB F097   4324     BEQ BFC54      ;return from IRQ
        4325 ;
        4326 ;set IRQ vector depending upon X
        4327 ;
FCBD BD93FD 4328 SFCBD LDA TFD9B-8,X ;move low byte of address
FCC0 8D1403 4329     STA X0314      ;into low byte of IRQ vector
FCC3 BD94FD 4330     LDA TFD9B-7,X ;then do high byte
FCC6 8D1503 4331     STA X0315
FCC9 60      4332     RTS
        4333 ;
        4334 ;stop cassette motor
        4335 ;
FCCA A501   4336 SFCCA LDA Z01
FCCC 0920   4337     ORA $20      ;set bit 5 high in 6510 I/O register
FCCE 8501   4338     STA Z01      ;to stop cassette motor
FCDO 60      4339     RTS
        4340 ;
        4341 ;compare ZAC/D with ZAE/F
        4342 ;
FCD1 38      4343 SFCD1 SEC
FCD2 A5AC   4344     LDA ZAC
FCD4 E5AE   4345     SBC ZAE      ;compare low parts
FCD6 A5AD   4346     LDA ZAD
FCD8 E5AF   4347     SBC ZAF      ;then high parts
FCDA 60      4348     RTS      ;C is clear when ZAC/D is low
        4349 ;
        4350 ;increment ZAC/D
        4351 ;
FCDB E6AC   4352 SFCDB INC ZAC      ;increment low
FCDD D002   4353     BNE BFCE1
FCDF E6AD   4354     INC ZAD      ;then high when necessary
FCE1 60      4355 BFCE1 RTS

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        4357 ;Reset routine
        4358 ;
FCE2 A2FF 4359 WFCE2 LDX $FF
FCE4 78    4360 SEL      ;disable IRQ
FCE5 9A    4361 TXS      ;set stack pointer
FCE6 D8    4362 CLD      ;clear decimal mode
FCE7 2002FD 4363 JSR SFD02 ;test for a cartridge
FCEA D003 4364 BNE BFCEF
FCEC 6C0080 4365 JMP (X8000) ;if found, execute cartridge Reset
        4366 ;
FCEF 8E16DD 4367 BFCEF STX XDO16 ;clear RES bit in video chip
FCF2 20A3FD 4368 JSR SFDA3 ;initialize I/O devices
FCF5 2050FD 4369 JSR SFD50 ;initialize memory pointers
FCF8 2015FD 4370 JSR SFD15 ;restore I/O vectors
FCFB 205BFF 4371 JSR JFF5B ;initialize screen and keyboard
FCFE 58    4372 CLI      ;enable IRQ
FCFF 6C00AO 4373 JMP (XA000) ;begin execution
        4374 ;
        4375 ;check for the presence of a cartridge
        4376 ;
FDO2 A205 4377 SFDO2 LDX $05 ;set length of key
FDO4 BD0FFD 4378 BFDO4 LDA TFD10-1,X ;compare table contents
FDO7 DD0380 4379 CMP X8004-1,X ;to cartridge contents
FDOA D003 4380 BNE BFDOF ;exit with Z clear upon mismatch
FDOC CA    4381 DEX
FDOD D0F5 4382 BNE BFDO4 ;repeat for 5 characters
FDOF 60    4383 BFDOF RTS ;Z set upon match
        4384 ;
        4385 ;cartridge key for autostart and warm start possibilities
        4386 ;
FD10 C3C2CD 4387 TFD10 .BY ^C+$80,^B+$80,^M+$80,^8,^0

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4389 ;restore I/O vectors
4390 ;
FD15 A230 4391 SFD15 LDX <TFD30      ;set XY to standard table
FD17 A0FD 4392 LDY >TFD30
FD19 18   4393 CLC           ;clear carry to use XY address
4394 ;
4395 ;set I/O vectors depending on XY
4396 ;
FD1A 86C3 4397 JFD1A STX ZC3      ;store XY in temporary pointer
FD1C 84C4 4398 STY ZC4
FD1E A01F 4399 LDY $1F          ;set count for move
FD20 B91403 4400 BFD20 LDA X0314,Y
FD23 B002 4401 BCS BFD27      ;if carry set, don't fetch from XY addr
FD25 B1C3 4402 LDA (ZC3),Y    ;move one byte
FD27 91C3 4403 BFD27 STA (ZC3),Y
FD29 991403 4404 STA X0314,Y    ;to I/O vector
FD2C 88   4405 DEY
FD2D 10F1 4406 BPL BFD20      ;repeat for 32 bytes
FD2F 60   4407 RTS
4408 ;
4409 ;vectors for Operating System at $0314-0333
4410 ;
FD30 31EA 4411 TFD30 .W WEA31    ;IRQ
FD32 66FE 4412 .W WFE66      ;BRK
FD34 47FE 4413 .W WFE47      ;NMI
FD36 4AF3 4414 .W WF34A       ;OPEN
FD38 91F2 4415 .W WF291      ;CLOSE
FD3A OEF2 4416 .W WF20E       ;set input device
FD3C 50F2 4417 .W WF250       ;set output device
FD3E 33F3 4418 .W WF333      ;restore I/O
FD40 57F1 4419 .W WF157      ;input
FD42 CAF1 4420 .W WF1CA       ;output
FD44 EDF6 4421 .W WF6ED       ;test Stop key
FD46 3EF1 4422 .W WF13E       ;get
FD48 2FF3 4423 .W WF32F       ;abort I/O
FD4A 66FE 4424 .W WF866       ;unused (BRK)
FD4C A5F4 4425 .W WF4A5       ;load RAM
FD4E EDF5 4426 .W WF5ED       ;save RAM

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        4428 ;initialize memory pointers
4429 ;
FD50 A900 4430 SFD50 LDA $00
FD52 A8    4431     TAY
FD53 990200 4432 BFD53 STA Z02,Y      ;clear page 0
FD56 990002 4433 STA X0200,Y      ;page 2
FD59 990003 4434 STA X0300,Y      ;and page 3
FD5C C8    4435     INY
FD5D D0F4  4436     BNE BFD53
FD5F A23C  4437     LDX $3C
FD61 A003  4438     LDY $03
FD63 86B2  4439     STX ZB2      ;set tape buffer pointer
FD65 84B3  4440     STY ZB3
FD67 A8    4441     TAY
FD68 A903  4442     LDA $03
FD6A 85C2  4443     STA ZC2      ;initialize page for RAM test
FD6C E6C2  4444 BFD6C INC ZC2      ;continue RAM test on next memory page
FD6E B1C1  4445 BFD6E LDA (ZC1),Y
FD70 AA    4446     TAX
FD71 A955  4447     LDA $55      ;save RAM contents
FD73 91C1  4448     STA (ZC1),Y
FD75 D1C1  4449     CMP (ZC1),Y
FD77 D00F  4450     BNE BFD88      ;if $55 not't read back, then end of RAM
FD79 2A    4451     ROL A
FD7A 91C1  4452     STA (ZC1),Y
FD7C D1C1  4453     CMP (ZC1),Y
FD7E D008  4454     BNE BFD88      ;if $AA not read back, then end of RAM
FD80 8A    4455     TXA
FD81 91C1  4456     STA (ZC1),Y      ;else restore original contents
FD83 C8    4457     INY
FD84 DOE8  4458     BNE BFD6E      ;continue on same page if not overflow
FD86 FOE4  4459     BEQ BFD6C      ;else continue test on next page
FD88 98    4460 BFD88 TYA
FD89 AA    4461     TAX
FD8A A4C2  4462     LDY ZC2
FD8C 18    4463     CLC
FD8D 202DFE 4464    JSR JFE2D      ;set top of memory pointer from XY
FD90 A908  4465     LDA $08
FD92 8D8202 4466    STA X0282      ;set bottom of memory pointer
FD95 A904  4467     LDA $04
FD97 8D8802 4468    STA X0288      ;set screen memory page
FD9A 60    4469     RTS
4470 ;
4471 ;IRQ vectors
4472 ;
FD9B 6AFC  4473 TFD9B .W WFC6A      ;X=$08, cassette write routine, part 1
FD9D CDFB  4474     .W WFBCD      ;X=$0A cassette write routine, part 2
FD9F 31EA  4475     .W WEA31      ;X=$0C standard IRQ routine
FDA1 2CF9  4476     .W WF92C      ;X=$0E cassette read routine

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        4478 ;initialize I/O devices
        4479 ;
FDA3 A97F 4480 SFDA3 LDA $7F      ;clear all mask bits in ICR1
FDA5 8DODDC 4481 STA XDCOD
FDA8 8DODDD 4482 STA XDDOD      ;and in ICR2
FDAB 8D0ODC 4483 STA XDCOO      ;set PA1 to $7F
FDAE A908 4484 LDA $08
FDB0 8D0EDC 4485 STA XDCOE      ;one-shot mode in CRA1
FDB3 8D0EDD 4486 STA XDDOE      ;and CRA2
FDB6 8D0FDC 4487 STA XDCOF      ;and CRB1
FDB9 8D0FDD 4488 STA XDDOF      ;and CRB2
FDBC A200 4489 LDX $00
FDBE 8E03DC 4490 STX XDCO3      ;DDRBL set to all inputs
FDC1 8E03DD 4491 STX XDDO3      ;DDRB2 set to all inputs
FDC4 8E18D4 4492 STX XD418      ;kill volume in SID chip
FDC7 CA 4493 DEX
FDC8 8E02DC 4494 STX XDCO2      ;DDRA1 set to all outputs
FDCB A907 4495 LDA $07
FDCD 8D0ODD 4496 STA XDD00      ;PA2 bits 0-2 set high
FDD0 A93F 4497 LDA $3F
FDD2 8D02DD 4498 STA XDDO2      ;DDRA2 bits 0-5 set to outputs
FDD5 A9E7 4499 LDA $E7
FDD7 8501 4500 STA Z01      ;initialize 6510 I/O register
FDD9 A92F 4501 LDA $2F
FDDB 8500 4502 STA Z00      ;and 6510 data direction register
        4503 ;
        4504 ;initialize TALL/TAH1 for 1/60 of a second
        4505 ;
FDDD ADA602 4506 SFDDD LDA X02A6
FDE0 F00A 4507 BEQ BFDEC      ;if this is an Intl. machine,
FDE2 A925 4508 LDA $25      ;use Intl value for 1/60 second delay
FDE4 8D04DC 4509 STA XDCO4
FDE7 A940 4510 LDA $40      ;high byte of value
FDE9 4CF3FD 4511 JMP JFDF3      ;go set high byte of timer
        4512 ;
FDEC A995 4513 BFDEC LDA $95      ;since this is US machine, use US value
FDEE 8D04DC 4514 STA XDCO4      ;for 1/60 second to set TALL
FDF1 A942 4515 LDA $42      ;high byte of value
FDF3 8D05DC 4516 JFDF3 STA XDCO5      ;set TAH1
FDF6 4C6EFF 4517 JMP JFF6E      ;go set CRAL for continuous timer IRQ's
        4518 ;
        4519 ;initialize file name parameters
        4520 ;
FDF9 85B7 4521 JFDF9 STA ZB7      ;set # of characters in file name
FDFB 86BB 4522 STX ZBB      ;set address of file name
FDFD 84BC 4523 STY ZBC      ;+ high byte
FDFF 60 4524 RTS
        4525 ;
        4526 ;initialize file parameters
        4527 ;
FE00 85B8 4528 JFE00 STA ZB8      ;set logical file
FE02 86BA 4529 STX ZBA      ;set current device
FE04 84B9 4530 STY ZB9      ;set secondary address
FE06 60 4531 RTS

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4533 ;read I/O status word
4534 ;
FE07 A5BA 4535 JFE07 LDA ZBA
FE09 C902 4536 CMP $02      ;if RS-232 device,
FE0B D00D 4537 BNE BFE1A
FE0D AD9702 4538 LDA X0297 ;read RS-232 Status Register
FE10 48    4539 PHA
FE11 A900 4540 LDA $00
FE13 8D9702 4541 STA X0297 ;then clear RS-232 Status Register
FE16 68    4542 PLA      ;and restore original contents in A
FE17 60    4543 RTS
4544 ;
4545 ;control kernal messages
4546 ;
FE18 859D 4547 JFE18 STA Z9D ;set direct/run mode ($80/$00)
4548 ;
4549 ;read ST
4550 ;
FE1A A590 4551 BFE1A LDA Z90 ;fetch current ST
4552 ;
4553 ;add A to current ST
4554 ;
FE1C 0590 4555 SFE1C ORA Z90 ;add existing bits to A
FE1E 8590 4556 STA Z90 ;and store new ST
FE20 60    4557 RTS
4558 ;
4559 ;set timeout on serial bus
4560 ;
FE21 8D8502 4561 JFE21 STA X0285 ;serial bus timeout flag (not used)
FE24 60    4562 RTS
4563 ;
4564 ;read/set top of memory
4565 ;
FE25 9006 4566 JFE25 BCC JFE2D ;if carry is clear, set pointers from XY
FE27 AE8302 4567 SFE27 LDX X0283 ;else fetch top of memory into XY
FE2A AC8402 4568 LDY X0284
FE2D 8E8302 4569 JFE2D STX X0283 ;set top of memory from X
FE30 8C8402 4570 STY X0284 ;and high byte from Y
FE33 60    4571 RTS
4572 ;
4573 ;read/set bottom of memory
4574 ;
FE34 9006 4575 JFE34 BCC BFE3C ;if carry is clear, set pointer from XY
FE36 AE8102 4576 LDX X0281 ;else fetch bottom of memory into XY
FE39 AC8202 4577 LDY X0282
FE3C 8E8102 4578 BFE3C STX X0281 ;set low byte bottom of memory from X
FE3F 8C8202 4579 STY X0282 ;and high byte from Y
FE42 60    4580 RTS

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4582 ;NMI entry
4583 ;
FE43 78 4584 WFE43 SEI
FE44 6C1803 4585     JMP (X0318)    ;perform NMI (normally FE47)
4586 ;
4587 ;standard NMI routine
4588 ;
FE47 48 4589 WFE47 PHA          ;save A on stack
FE48 8A 4590     TXA
FE49 48 4591     PHA          ;save X on stack
FE4A 98 4592     TYA
FE4B 48 4593     PHA          ;save Y on stack
FE4C A97F 4594     LDA $7F
FE4E 8DODDD 4595     STA XDDOD   ;clear ICR2 IRQ mask bits
FE51 ACODDD 4596     LDY XDDOD
FE54 301C 4597     BMI BFE72   ;if no IRQ's were present
FE56 2002FD 4598     JSR SFD02   ;check for a cartridge
FE59 D003 4599     BNE BFE5E   ;if cartridge present,
FE5B 6C0280 4600     JMP (X8002)  ;perform cartridge warm start
4601 ;
FE5E 20BCF6 4602 BFE5E JSR BF6BC  ;scan the keyboard
FE61 20E1FF 4603     JSR SFFE1   ;check for Stop key
FE64 D00C 4604     BNE BFE72   ;and drop thru to BRK if depressed
4605 ;
4606 ;BRK routine
4607 ;
FE66 2015FD 4608 WFE66 JSR SFD15  ;restore I/O vectors
FE69 20A3FD 4609     JSR SFDA3   ;initialize I/O devices
FE6C 2018E5 4610     JSR SE518   ;initialize screen and keyboard
FE6F 6C02A0 4611     JMP (XA002)  ;perform warm start

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        4613 ;internal NMI
        4614 ;
FE72 98    4615 BFE72 TYA      ;get ICR2
FE73 2DA102 4616     AND X02A1 ;mask with ICR2 activity register
FE76 AA    4617     TAX       ;save results
FE77 2901  4618     AND $01
FE79 F028  4619     BEQ BFEA3 ;if transmitting
FE7B ADOODD 4620    LDA XDD00
FE7E 29FB  4621     AND $FB ;clear RS-232 output data line
FE80 05B5  4622    ORA ZB5   ;and add bit to be transmitted
FE82 8D0DDD 4623    STA XDD00 ;and send it
FE85 ADA102 4624    LDA X02A1 ;use ICR2 activity register
FE88 8D0DDD 4625    STA XDD0D ;to set ICR2
FE8B 8A    4626     TXA
FE8C 2912  4627    AND $12 ;if not receiving/waiting receiver edge,
FE8E F00D  4628    BEQ BFE9D ;send next bit on serial bus
FE90 2902  4629    AND $02
FE92 F006  4630    BEQ BFE9A ;if not receiving,
FE94 20D6FE 4631    JSR SFED6 ;input next bit on RS-232
FE97 4C9DFE 4632    JMP BFE9D ;then send next bit on RS-232 bus
        4633 ;
FE9A 2007FF 4634 BFE9A JSR SFF07 ;schedule TB2 using baud rate factor
FE9D 20BBEE 4635 BFE9D JSR SEEBB ;send next bit on RS-232
FEAO 4CB6FE 4636    JMP JFEB6 ;exit from NMI
        4637 ;
FEA3 8A    4638 BFEA3 TXA
FEA4 2902  4639    AND $02
FEA6 F006  4640    BEQ BFEAE ;if receiving data,
FEA8 20D6FE 4641    JSR SFED6 ;input next bit on RS-232, schedule TB2
FEAB 4CB6FE 4642    JMP JFEB6 ;exit from NMI
        4643 ;
FEAE 8A    4644 BFEAE TXA
FEAF 2910  4645    AND $10
FEB1 F003  4646    BEQ JFEB6 ;if waiting for receiver edge,
FEB3 2007FF 4647    JSR SFF07 ;schedule TB2 using baud rate factor
FEB6 ADA102 4648 JFEB6 LDA X02A1 ;use ICR2 activity register
FEB9 8D0DDD 4649    STA XDD0D ;to set ICR2
FEBc 68    4650 JFEBc PLA ;restore Y
FEBD A8    4651     TAY
FEBE 68    4652     PLA
FEBF AA    4653     TAX ;restore X
FEC0 68    4654     PLA ;restore A
FEC1 40    4655     RTI ;and return from NMI

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4657 ;table of baud rate factors based upon
4658 ;((clock frequency/baud rate/2)-100)
4659 ;this table applies to US machine clock frequency
4660 ;
FEC2 C127 4661 TFEC2 .W $27C1 ;50 baud
FEC4 3E1A 4662 .W $1A3E ;75
FEC6 C511 4663 .W $11C5 ;110
FEC8 740E 4664 .W $0E74 ;134.5
FECA EDOC 4665 .W $0CED ;150
FECC 4506 4666 .W $0645 ;300
FECE F002 4667 .W $02F0 ;600
FED0 4601 4668 .W $0146 ;1200
FED2 B800 4669 .W $00B8 ;1800
FED4 7100 4670 .W $0071 ;2400
4671 ;
4672 ;input next bit on RS-232 bus and schedule TB2
4673 ;
FED6 AD01DD 4674 SFED6 LDA XDD01
FED9 2901 4675 AND $01 ;mask bit read
FEDB 85A7 4676 STA ZA7 ;and save in temporary storage area
FEDD AD06DD 4677 LDA XDD06 ;use TAL2
FEE0 E91C 4678 SBC $1C ;and overhead
FEE2 6D9902 4679 ADC X0299 ;and baud rate full bit time
FEE5 8D06DD 4680 STA XDD06 ;to reset TBL2
FEE8 AD07DD 4681 LDA XDD07
FEEB 6D9A02 4682 ADC X029A
FEEE 8D07DD 4683 STA XDD07 ;and TBH2
FEF1 A911 4684 LDA $11
FEF3 8DOFDD 4685 STA XDD0F ;set force load + start TB2 bits in CRB2
FEF6 ADA102 4686 LDA X02A1
FEF9 8D0DDD 4687 STA XDD0D ;set ICR2 from ICR2 activity register
FEFC A9FF 4688 LDA $FF
FEFE 8D06DD 4689 STA XDD06 ;set TBL2
FF01 8D07DD 4690 STA XDD07 ;and TBH2 to maximum value
FF04 4C59EF 4691 JMP JEF59 ;add input bit to word being read
4692 ;
4693 ;schedule TB2 using baud rate factor
4694 ;
FF07 AD9502 4695 SFF07 LDA X0295 ;move bit time
FF0A 8D06DD 4696 STA XDD06 ;to TBL2
FF0D AD9602 4697 LDA X0296
FF10 8D07DD 4698 STA XDD07 ;and TBH2
FF13 A911 4699 LDA $11
FF15 8DOFDD 4700 STA XDD0F ;set force load and TB in CRB2
FF18 A912 4701 LDA $12
FF1A 4DA102 4702 EOR X02A1 ;invert waiting for receiver edge and
FF1D 8DA102 4703 STA X02A1 ;receiving data bits in activity reg
FF20 A9FF 4704 LDA $FF
FF22 8D06DD 4705 STA XDD06 ;set TBL2 to maximum value
FF25 8D07DD 4706 STA XDD07 ;set TBH2 to maximum value
FF28 AE9802 4707 LDX X0298
FF2B 86A8 4708 STX ZA8 ;set number of bits to send/receive
FF2D 60 4709 RTS

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        4711 ;continuation of baud rate calcuation
4712 ;
FF2E AA    4713 SFF2E TAX
FF2F AD9602 4714      LDA X0296
FF32 2A    4715      ROL A      ;multiply factor * 2
FF33 A8    4716      TAY
FF34 8A    4717      TXA
FF35 69C8  4718      ADC $C8      ;and add 200
FF37 8D9902 4719      STA X0299      ;to form baud rate
FF3A 98    4720      TYA
FF3B 6900  4721      ADC 0
FF3D 8D9A02 4722      STA X029A
FF40 60    4723      RTS
4724 ;
FF41 EA    4725      NOP
FF42 EA    4726      NOP
4727 ;
FF43 08    4728 JFF43 PHP
FF44 68    4729      PLA
FF45 29EF  4730      AND $EF      ;clear BRK status bit
FF47 48    4731      PHA
4732 ;
4733 ;IRQ entry point
4734 ;
FF48 48    4735 WFF48 PHA      ;save A on stack
FF49 8A    4736      TXA
FF4A 48    4737      PHA      ;save X on stack
FF4B 98    4738      TYA
FF4C 48    4739      PHA      ;save Y on stack
FF4D BA    4740      TSX
FF4E BD0401 4741      LDA X0100+4,X ;check BRK bit
FF51 2910  4742      AND $10
FF53 F003  4743      BEQ BFF58
FF55 6C1603 4744      JMP (X0316) ;perform BRK (normally FE66)
4745 ;
FF58 6C1403 4746 BFF58 JMP (X0314) ;else IRQ (normally EA31)
4747 ;
4748 ;addition to I/O device initialization
4749 ;
FF58 2018E5 4750 JFF5B JSR SE518      ;initialize screen and keyboard
FF5E AD12D0 4751 BFF5E LDA X0D12
FF61 D0FB  4752      BNE BFF5E      ;wait for raster count to clear
FF63 AD19D0 4753      LDA X0D19      ;use interrupt register
FF66 2901  4754      AND $01
FF68 8DA602 4755      STA X02A6      ;to set US/Intl machine flag (0=US)
FF6B 4CDDFD 4756      JMP SFDDD      ;set clock for 1/60 second IRQ's
4757 ;
4758 ;end of scheduling TA for 1/60 second IRQ's
4759 ;
FF6E A981  4760 JFF6E LDA $81
FF70 8D0DDC 4761      STA XDCOD      ;set TA mask in ICRL
FF73 ADOEDC 4762      LDA XDCOE      ;use CRA1
FF76 2980  4763      AND $80      ;bit 7 (50/60 Hz flag)
FF78 0911  4764      ORA $11      ;+ force load, continuous mode and TAI
FF7A 8D0EDC 4765      STA XDCOE      ;to set CRA1
FF7D 4C8EEE 4766      JMP SEE8E      ;set serial clock line high and return
FF80 00    4767      .BY $00      ;filler

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4769 ;kernal vectors
4770 ;
FF81 4C5BFF 4771      JMP JFF5B    ;initialize screen and keyboard
4772 ;
FF84 4CA3FD 4773      JMP SFDA3    ;initialize I/O devices
4774 ;
FF87 4C50FD 4775      JMP SFD50    ;initialize memory pointers
4776 ;
FF8A 4C15FD 4777      JMP SFD15    ;restore I/O vectorsces
4778 ;
FF8D 4C1AFD 4779      JMP JFD1A    ;set I/O vectors from XY
4780 ;
FF90 4C18FE 4781      JMP JFE18    ;control kernal messages
4782 ;
FF93 4CB9ED 4783      JMP SEDB9    ;send Secondary Address after Listen
4784 ;
FF96 4CC7ED 4785      JMP SEDC7    ;send Secondary Address after Talk
4786 ;
FF99 4C25FE 4787      SFF99 JMP JFE25  ;read/set top of memory
4788 ;
FF9C 4C34FE 4789      SFF9C JMP JFE34  ;read/set bottom of memory
4790 ;
FF9F 4C87EA 4791      JMP SEA87    ;scan keyboard
4792 ;
FFA2 4C21FE 4793      JMP JFE21    ;set timeout for serial bus
4794 ;
FFA5 4C13EE 4795      JMP JEE13    ;input byte on serial bus
4796 ;
FFA8 4CDDED 4797      JMP JEDDD    ;output byte on serial bus
4798 ;
FFAB 4CEFED 4799      JMP SEDEF    ;send Untalk on serial bus
4800 ;
FFAE 4CFEED 4801      JMP SEDFE    ;send Unlisten on serial bus
4802 ;
FFB1 4COCED 4803      JMP SEDOC    ;send Listen on serial bus
4804 ;
FFB4 4C09ED 4805      JMP SEDO9    ;send Talk on serial bus
4806 ;
FFB7 4C07FE 4807      SFFB7 JMP JFE07  ;read I/O status word
4808 ;
FFBA 4C00FE 4809      SFFBA JMP JFE00  ;set file parameters
4810 ;
FFBD 4CF9FD 4811      SFFBD JMP JFDF9  ;set file name parameters
4812 ;
FFC0 6C1A03 4813      SFFCO JMP (X031A) ;open a file (F34A)
4814 ;
FFC3 6C1C03 4815      SFFC3 JMP (X031C) ;close a file (F291)
4816 ;
FFC6 6C1E03 4817      SFFC6 JMP (X031E) ;set input device (F20E)
4818 ;
FFC9 6C2003 4819      SFFC9 JMP (X0320) ;set output device (F250)
4820 ;
FFCC 6C2203 4821      SFFCC JMP (X0322) ;restore I/O devices to default (F333)
4822 ;
FFCF 6C2403 4823      SFFCF JMP (X0324) ;input char on current device (F157)
4824 ;
FFD2 6C2603 4825      SFFD2 JMP (X0326) ;output char to current device (F1CA)
4826 ;
FFD5 4C9EF4 4827      SFFD5 JMP JF49E  ;load RAM from a device
4828 ;

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FFD8 4CDDF5 4829 SFFD8 JMP JF5DD ;save RAM to a device
                                4830 ;
FFDB 4CE4F6 4831      JMP JF6E4 ;set real time clock
                                4832 ;
FFDE 4CDDF6 4833      JMP JF6DD ;read real time clock
                                4834 ;
FFE1 6C2803 4835 SFFE1 JMP (X0328) ;check Stop key (F6ED)
                                4836 ;
FFE4 6C2A03 4837 SFFE4 JMP (X032A) ;get a character (Fl3E)
                                4838 ;
FFE7 6C2C03 4839      JMP (X032C) ;close all channels and files (F32F)
                                4840 ;
FFEA 4C9BF6 4841 SFFEA JMP JP69B ;increment real time clock
                                4842 ;
FFED 4C05E5 4843      JMP JE505 ;read organization of screen into XY
                                4844 ;
FFF0 4COAE5 4845      JMP JE50A ;read/set XY cursor position
                                4846 ;
FFF3 4COOE5 4847 SFFF3 JMP JE500 ;read base address of I/O devices
                                4848 ;
                                4849 ;garbage
                                4850 ;
FFF6 525242 4851      .BY $52,$52,$42,$59
                                4852 ;
                                4853 ;6510 fixed vectors
                                4854 ;
FFFA 43FE 4855      .W WFE43 ;NMI vector
FFFFC E2FC 4856      .W WFCE2 ;RESET vector
FFFFE 48FF 4857      .W WFF48 ;IRQ/BRK vector
```

BE00B	E00B	333
BE00E	E00E	327
BE01E	E01E	343
BE06C	E06C	379
BE07O	E07O	396
BE07D	E07D	388
BE0BE	EOBE	410
BE0D3	E0D3	409
BE0F9	EOF9	470 474 478 482 486 520 587
BE104	E104	459
BE109	E109	465
BE194	E194	546 586
BE195	E195	539
BE19E	E19E	543
BE1A1	E1A1	554
BE1B5	E1B5	560
BE1D1	E1D1	537 578
BE20D	E20D	618 627
BE23F	E23F	647
BE29D	E29D	688 727
BE2A0	E2A0	691
BE2AD	E2AD	700
BE316	E316	756
BE324	E324	761
BE337	E337	770
BE33D	E33D	775
BE386	E386	833
BE391	E391	821
BE3A8	E3A8	838
BE3B9	E3B9	842
BE3E2	E3E2	876
BE421	E421	902
BE455	E455	941
BE4B6	E4B6	960
BE4E2	E4E2	985
BE4EB	E4EB	983
BE513	E513	1016
BE54D	E54D	1056
BE555	E555	1052
BE560	E560	1062
BE570	E570	1077
BE57C	E57C	1072
BE58D	E58D	1091
BE597	E597	1087
BE5AA	E5AA	1108
BE5B9	E5B9	1119
BE5CA	E5CA	1154
BE5CD	E5CD	1132 1151 1187
BE5E7	E5E7	1135
BE5F3	E5F3	1150
BE5FE	E5FE	1143
BE606	E606	1161
BE60F	E60F	1159
BE63A	E63A	1169 1173 1177
BE64A	E64A	1197
BE650	E650	1199
BE654	E654	1201 1202
BE65D	E65D	1178
BE66F	E66F	1213

BE672	E672	1216
BE674	E674	1207
BE682	E682	1226
BE690	E690	1234
BE699	E699	1245
BE69F	E69F	1248
BE6A8	E6A8	1317 1407 1425 1475 1506 1509 1514 1541 2007 2019
BE6B0	E6B0	1259
BE6CD	E6CD	1278
BE6DA	E6DA	1283 1674 1708
BE6F4	E6F4	1299
BE6F7	E6F7	1276
BE700	E700	1274
BE70B	E70B	1313
BE72A	E72A	1337
BE731	E731	1341
BE73D	E73D	1347
BE73F	E73F	1349
BE745	E745	1345
BE74C	E74C	1355
BE759	E759	1361
BE762	E762	1379
BE77E	E77E	1359
BE785	E785	1386
BE78B	E78B	1390
BE792	E792	1393
BE7A8	E7A8	1417 1418
BE7AA	E7AA	1402
BE7AD	E7AD	1396
BE7CO	E7CO	1423
BE7C8	E7C8	1421
BE7CB	E7CB	1384
BE7CE	E7CE	1410
BE7DC	E7DC	1434
BE7E3	E7E3	1437
BE7EA	E7EA	1441
BE7FE	E7FE	1451
BE805	E805	1453
BE80A	E80A	1469
BE826	E826	1455
BE829	E829	1447
BE82D	E82D	1445
BE832	E832	1478
BE847	E847	1490
BE84C	E84C	1483
BE854	E854	1496
BE864	E864	1502
BE86A	E86A	1500
BE871	E871	1485 1492 1494
BE874	E874	1512
BE880	E880	1529
BE888	E888	1526
BE8A5	E8A5	1552
BE8B0	E8B0	1548
BE8B7	E8B7	1567
BE8C2	E8C2	1563
BE8CA	E8CA	1572
BE8CD	E8CD	1582
BE8D6	E8D6	1580
BE8F6	E8F6	1630

BE8FF	E8FF	1614
BE913	E913	1609
BE918	E918	1625
BE922	E922	1620
BE94D	E94D	1645 1647
BE956	E956	1641
BE981	E981	1668 1669
BE98F	E98F	1694
BE9A6	E9A6	1688 1689
BE9AB	E9AB	1706
BE9BA	E9BA	1702
BE9BF	E9BF	1698
BE9D4	E9D4	1723
BEA07	EA07	1757
BEA5C	EA5C	1799
BEA61	EA61	840 1790 1792
BEA71	EA71	1811
BEA79	EA79	1816
BEA7B	EA7B	1818
BEAA8	EAA8	1875
BEAAB	EAAB	1852
BEAB3	EAB3	1870
BEAC9	EAC9	1858 1860
BEACB	EACB	1863
BEACC	EACC	1854
BEADC	EADC	1868
BEAFO	EAF0	1883
BEAFB	EAFB	1840
BEB0D	EB0D	1890 1895 1897 1899
BEB17	EB17	1903
BEB26	EB26	1886 1893
BEB42	EB42	1891 1901 1905 1907 1912 1918 1922 1934
BEB64	EB64	1932
BEB6B	EB6B	1946
BEB76	EB76	1936 1940
BEC58	EC58	2001
BEC5B	EC5B	2015
BEC5E	EC5E	2003
BEC69	EC69	2010
BEC72	EC72	2013
BED20	ED20	2104
BED2E	ED2E	2115
BED50	ED50	2135
BED55	ED55	2137
BED5A	ED5A	2133 2139
BED66	ED66	2145 2163
BED7A	ED7A	2149
BED7D	ED7D	2151
BED9F	ED9F	2173
BEDAD	EDAD	2130
BEDBO	EDBO	2147 2171
BEDD6	EDD6	2203
BEDE6	EDE6	2210
BEDEB	EDEB	2213
BEE03	EE03	2183
BEE09	EE09	2239
BEE1B	EE1B	2251
BEE20	EE20	2274
BEE30	EE30	2262
BEE3E	EE3E	2260

BEE47	EE47 2265
BEE56	EE56 2263
BEE5A	EE5A 2279 2281 2289
BEE67	EE67 2285 2287
BEE80	EE80 2292
BEEB6	EEB6 2342
BEEC8	EEC8 2353
BEED1	EED1 2375 2377 2387
BEED7	EED7 2359
BEEE6	EEE6 2379 2382 2384
BEEE7	EEE7 2371 2381 2383
BEEF2	EEF2 2367
BEEF6	EEF6 2369
BEEFC	EEFC 2368
BEFO0	EF00 2350
BEFO6	EF06 2349 2565
BEF13	EF13 2390
BEF2E	EF2E 2392
BEF31	EF31 2393
BEF39	EF39 2401
BEF54	EF54 2427
BEF58	EF58 2429
BEF6D	EF6D 2457 2495 2499 2501
BEF6E	EF6E 2494
BEF70	EF70 2440
BEF7E	EF7E 2472 2511
BEF90	EF90 2437
BEF97	EF97 2439
BEFA9	EFA9 2490
BEFB1	EFB1 2487
BEFC5	EFC5 2498
BEFCA	EFCA 2481
BEFCD	EFC D 2515
BEFD0	EF D0 2514
BEFD8	EFDB 2452
BEFF2	EFF2 2529
BEFF9	EFF9 2531
BF006	F006 2537
BF00D	FOOD 2525 2580 3135
BF012	F012 2522 2526 2536
BF014	F014 2549
BF04C	F04C 2556
BF062	F062 2584
BF070	F070 2590
BF077	F077 2597
BF07D	F07D 2575 2577
BF084	F084 2581
BF09C	F09C 2606
BF0AA	FOAA 2625
BF0BB	FOBB 2622
BF12F	F12F 2658 3320 3324 3445 3534 3565 3695 3700
BF13C	F13C 2651
BF14A	F14A 2665
BF155	F155 2667
BF166	F166 2672 2682
BF173	F173 2690
BF18D	F18D 2705
BF193	F193 2704
BF196	F196 2701
BF1A9	F1A9 2722

BF1AD	F1AD	2696
BF1B1	F1B1	2750
BF1B3	F1B3	2747
BF1B4	F1B4	2724 2745
BF1B5	F1B5	2733
BF1B8	F1B8	2698 2751
BF1D5	F1D5	2758
BF1DB	F1DB	2762
BF1F8	F1F8	2775
BF1FD	F1FD	2777*
BF207	F207	2791
BF208	F208	2773
BF216	F216	2801
BF22A	F22A	2811
BF233	F233	2806 2808 2816 2835
BF237	F237	2809
BF245	F245	2828
BF258	F258	2841
BF25F	F25F	2858
BF262	F262	2846
BF26F	F26F	2853
BF275	F275	2850 2874
BF279	F279	2851
BF286	F286	2868
BF289	F289	2870
BF298	F298	2880
BF2BA	F2BA	2899
BF2BF	F2BF	2902
BF2C8	F2C8	2893
BF2EO	F2EO	2919
BF2EE	F2EE	2891
BF2F1	F2F1	2888 2890 2913 2926 2929
BF30D	F30D	2941
BF316	F316	2961
BF32E	F32E	2959
BF33C	F33C	2983
BF343	F343	2986
BF351	F351	2996
BF359	F359	3000
BF362	F362	3005
BF384	F384	3020
BF38B	F38B	3024
BF393	F393	3030
BF3AC	F3AC	3049
BF3AF	F3AF	3040
BF3B8	F3B8	3035
BF3C2	F3C2	3042 3048
BF3D1	F3D1	3060
BF3D3	F3D3	3017 3019 3022 3072 3074
BF3D4	F3D4	3037 3043 3047 3054
BF3F6	F3F6	3083
BF3FC	F3FC	3095
BF406	F406	3089
BF40F	F40F	3108
BF41D	F41D	3103
BF43A	F43A	3117
BF446	F446	3113
BF45C	F45C	3131 3134
BF474	F474	3143
BF4AF	F4AF	3186

BF4B2	F4B2	3182
BF4BF	F4BF	3189
BF4FO	F4FO	3210
BF4F3	F4F3	3228 3243
BF501	F501	3220
BF51C	F51C	3231
BF51E	F51E	3234
BF524	F524	3240
BF530	F530	3206 3265 3268
BF533	F533	3187
BF539	F539	3250
BF541	F541	3254
BF549	F549	3276
BF556	F556	3261
BF55D	F55D	3263
BF56C	F56C	3285
BF579	F579	3274
BF57D	F57D	3283
BF5A9	F5A9	3246
BF5AE	F5AE	3258 3264 3267 3272
BF5C7	F5C7	3332
BF5D1	F5D1	3318 3322 3326
BF5DA	F5DA	3339
BF5F1	F5F1	3361 3417
BF5F4	F5F4	3357
BF605	F605	3366
BF624	F624	3393
BF63A	F63A	3386
BF63F	F63F	3382
BF657	F657	3399
BF659	F659	3362
BF65F	F65F	3411
BF676	F676	3424
BF68D	F68D	3433
BF68E	F68E	3419 3428 3430 3443
BF6A7	F6A7	3452 3454
BF6BC	F6BC	3463 3469 3787 4602
BF6CC	F6CC	3476
BF6DA	F6DA	3471
BF6DC	F6DC	3479
BF6FA	F6FA	3503
BF729	F729	3533
BF74B	F74B	3556 3558
BF757	F757	3571
BF761	F761	
BF767	F767	3563
BF769	F769	3550 3554
BF781	F781	3596
BF7A5	F7A5	3623
BF7B7	F7B7	3617
BF7CF	F7CF	3583
BF7F7	F7F7	3678
BF80B	F80B	3670
BF80C	F80C	3664
BF81E	F81E	3716
BF821	F821	3698
BF836	F836	3693 3706 3714
BF86E	F86E	3725
BF875	F875	3736
BF8B5	F8B5	3780

BF8B7	F8B7 3778
BF8DC	F8DC 3744 3785
BF8E1	F8E1 3794
BF8F7	F8F7 3816
BF8FE	F8FE 3825
BF92A	F92A 3836 3837 3839
BF92C	F92C 3853
BF969	F969 3875
BF988	F988 3879 3925
BF98B	F98B 3893 3929 3943
BF993	F993 3884
BF997	F997 3889 3969
BF999	F999 3901
BF9AC	F9AC 3873 3897 3899 3945 3947 3949
BF9BC	F9BC 3917
BF9C9	F9C9 3956
BF9D2	F9D2 3914 3919 3954
BF9D5	F9D5 3911
BF9DE	F9DE 3934
BF9E0	F9E0 3933
BF9F7	F9F7 3924 3941
BFA18	FA18 3964
BFA1F	FA1F 3966 3968
BFA44	FA44 3981
BFA53	FA53 3992
BFA5D	FA5D 3983
BFA70	FA70 4011
BFA86	FA86 4017
BFA8A	FA8A 4020 4023 4031 4033 4044 4050 4053
BFA8D	FA8D 4015
BFAA3	FAA3 4037
BFAA9	FAA9 4029
BFBABA	FABA 4038 4040
BFBACO	FACO 4028
BFACE	FACE 4055
BFD6	FAD6 4062
BFAEB	FAEB 4069 4073
BFB08	FB08 4067
BFB2F	FB2F 4103
BFB33	FB33 4080
BFB3A	FB3A 4077 4089 4111
BFB43	FB43 4093 4096 4099 4107 4114 4116
BFB5C	FB5C 4130
BFB68	FB68 4133
BFB72	FB72 4147
BFB8B	FB8B 4121 4135 4137 4150
BFBAF	FBAB 4179 4283
BFBBC8	FBC8 4251
BFBB3	FBE3 4201
BFBFO	FBFO 4212
BFC09	FC09 4199 4205 4208 4214 4216 4218 4235 4248 4255 4262
BFC0C	FCOC 4222
BFC16	FC16 4300
BFC2C	FC2C 4245
BFC30	FC30 4239
BFC3F	FC3F 4250
BFC4E	FC4E 4234
BFC54	FC54 4276 4284 4286 4289 4324
BFC5E	FC5E 4269
BFCB6	FCB6 4314

BFCB8	FCB8	4295
BFCE1	FCE1	4353
BFCEF	FCEF	4364
BFD04	FD04	4382
BFD0F	FD0F	4380
BFD20	FD20	4406
BFD27	FD27	4401
BFD53	FD53	4436
BFD6C	FD6C	4459
BFD6E	FD6E	4458
BFD88	FD88	4450 4454
BFDEC	FDEC	4507
BFE1A	FE1A	4537
BFE3C	FE3C	4575
BFE5E	FE5E	4599
BFE72	FE72	4597 4604
BFE9A	FE9A	4630
BFE9D	FE9D	4628 4632
BFEA3	FEA3	4619
BFFAE	FFAE	4640
BFF58	FF58	4743
BFF5E	FF5E	4752
JE043	E043	704 767
JE0E3	EOE3	426
JE500	E500	4847
JE505	E505	4843
JE50A	E50A	4845
JE566	E566	1096 1394
JE632	E632	2687 2694
JE691	E691	1438
JE693	E693	1352
JE697	E697	1356 1387 1480
JE773	E773	1363
JE7D4	E7D4	1338
JE891	E891	1342 1442
JE958	E958	1709
JE967	E967	1279 1665
JEAEO	EAE0	1953
JEC44	EC44	1428
JEC4F	EC4F	1518 1998
JEDB2	EDB2	2267
JEDDO	EDDD	2764 3092 3378 3380 3384 4797
JEE13	EE13	2740 3201 3207 3223 4795
JEF3B	EF3B	2467 2564 2593
JEF59	EF59	4691
JEFE1	EFE1	2854
JF04D	FO4D	2812
JF12B	F12B	3341
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SE206	E206	596 598 603 641 650 657
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SE257	E257	597
SE26B	E26B	711
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SEA1C	EA1C	1808	
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SEA87	EA87	1822	4791
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SF817	F817	3036	3257 3724
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TA376	A376	563 564
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TBFC4	BFC4	348 349
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TE092	E092	434 435
TE2E0	E2E0	667 668 771 772
TE2E5	E2E5	674 675
TE2EA	E2EA	683 684 696 697
TE2EF	E2EF	702 703
TE33E	E33E	765 766
TE3A2	E3A2	844 873
TE447	E447	938
TE460	E460	921 922
TE473	E473	911 912
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TEB81	EB81	1842 1844 1957
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TF0D8	FOD8	
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TF120	F120	
TF127	F127	
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WB391	B391	864 865
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WE12A	E12A	
WE147	E147	493 495
WE156	E156	
WE165	E165	
WE168	E168	
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WF20E	F20E	4416
WF250	F250	4417
WF291	F291	4415
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WF5ED	F5ED	4426
WF6ED	F6ED	4421
WF92C	F92C	4476
WFBCD	FBCD	4474
WFC6A	FC6A	4473

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WFE66	FE66	4412 4424
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XA002	A002	4611
XA408	A408	910
XA437	A437	467 556
XA43A	A43A	822
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XA533	A533	571
XA644	A644	924
XA663	A663	462
XA677	A677	572
XA67A	A67A	813
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XD012	D012	4751
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ZC3	00C3	3172	3211	3279	3298	3303	4397	4402	4403				
ZC4	00C4	3173	3213	3282	3301	3305	4398						
ZC5	00C5	1882	1914										
ZC6	00C6	1118	1120	1129	1146	1648	1910	1920	1925	2666	3506		
ZC7	00C7	1244	1391	1498	1537								
ZC8	00C8	1163	1176	1206	2693								
ZC9	00C9	1168	1172	1522	1604	2686							
ZCA	00CA	1174	2684										
ZCB	00CB	1836	1864	1879	1913								
ZCC	00CC	1043	1130	1789									
ZCD	00CD	1042	1764	1791	1794								
ZCE	00CE	1136	1801	1806									
ZCF	00CF	1029	1134	1139	1796	1800							
ZDO	00DO	1156	1186	1209	1334	2691							
ZD1	00D1	1083	1157	1192	1370	1372	1381	1449	1460	1462	1471	1719	1740
		1753	1771	1778	1798								
ZD2	00D2	1081	1744	1780									
ZD3	00D3	1018	1021	1064	1070	1075	1166	1175	1191	1204	1271	1273	1307
		1314	1322	1335	1367	1399	1406	1422	1452	1468	1487	1491	1505
		1539	1547	1562	1770	1795	2683						
ZD4	00D4	1167	1200	1235	1237	1260	1385	1444	1538				
ZD5	00D5	1092	1155	1272	1294	1297	1321	1378	1401	1416	1448	1457	2692
ZD6	00D6	1017	1020	1065	1069	1170	1281	1285	1286	1304	1312	1319	1403
		1415	1419	1484	1486	1523	1530	1555	1570	1573	1603	1631	1649
		1662	1673	2685									
ZD7	00D7	1193	1195	1196	1219	1224	1328	1336	3912	3940	3957	4241	4253
		4259	4260										
ZD8	00D8	1247	1249	1258	1354	1474	1477	1536	1692				
ZD9	00D9	1049	1058	1071	1078	1086	1287	1288	1290	1292	1298	1528	1617
		1622	1629	1664	1701	1741							

ZDA	00DA	1612	1619	1699	1704							
ZF1	00F1	1626	1628									
ZF3	00F3	975	1374	1376	1383	1464	1466	1473	1721	1773	1779	1803
ZF4	00F4	1783										
ZF5	00F5	1843	1856	1880	1950							
ZF6	00F6	1845	1952									
ZF7	00F7	2491	2609	3146								
ZF8	00F8	2898	2905	3142	3145							
ZF9	00F9	2402	2553	3151								
ZFA	00FA	2901	2906	3147	3150							

The End